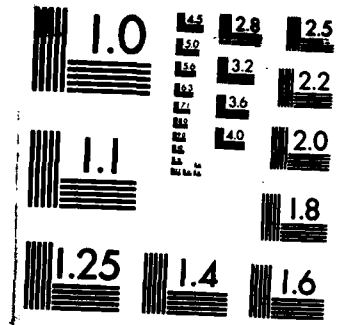
AD-A155 640 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS NOTOWN RESERVOIR DAM A..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV MAR 80 1/4

UNCLASSIFIED F/G 13/13 NL



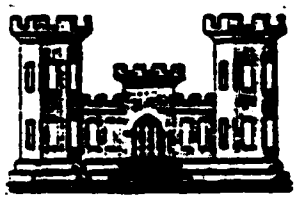
MERRIMACK RIVER BASIN
LEOMINSTER, MASSACHUSETTS

AD-A155 640

NOTOWN RESERVOIR DAM AND DIKE

DAM — 00870
DIKE — 01240

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

MARCH 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MA 00870/01240	2. GOVT ACCESSION NO. AD-A155640	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Notown Reservoir Dam and Dike NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE March 1980 13. NUMBER OF PAGES 85
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Leiminster, Massachusetts
Monoosnoc Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The main dam is 600 ft. long with a hydraulic height of 21 ft. The dike is 750 ft. long with a hydraulic height if 13 ft. Both have a size of intermediate with a hazard potential of high. The dam was in generally fair condition. But due to some damages it was given the overall rating of poor. Generally the dike was in good condition.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF
NEDED

MAY 23 1980

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King.

Inclosed is a copy of the Notown Reservoir Dam & Dike Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, City of Leominster, Leominster, Massachusetts 01453.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INVESTIGATION REPORT
BRIEF ASSESSEMENT

Identification No.:	MA 00870 Dam; MA 01240 Dike
Name of Dam:	Notown Reservoir Dam and Dike
City:	Leominster
County and State:	Worcester County, Massachusetts
Stream:	Monoosnoc Brook
Date of Inspection:	October 24 and November 5, 1979

The main dam is 600 feet long with a hydraulic height of 21 feet. It contains a sheet piling and concrete upstream cut-off. The dike is 750 feet long with a hydraulic height of 13 feet. It is indicated on plans to have a stone masonry core wall. The original dam was probably built prior to 1876. Modifications were made in 1894 and 1930. The reservoir has always been owned and operated by the City of Leominster as a part of their water supply system.

Indepth engineering data was not available. The adequacy of the dam was primarily evaluated by visual inspection, past performance history, a limited number of existing drawings and sound engineering judgement.

The dam and dike have size classifications of intermediate and hazard potential classifications of high. Based upon Corps Guidelines the test flood is the PMF. The inflow from the 4.57 s.m. drainage area is 8,600 cfs. The spillway's capacity with the 8 inch flashboards in place, is about 1,850 cfs or

-37 percent of test flood outflow, at the top of dam. With the flashboards in place, the test flood outflow, 5,070 cfs, surcharges the reservoir to elevation 741.5. The dam and dike and a small section of Route 2 are overtopped by 0.9 feet.

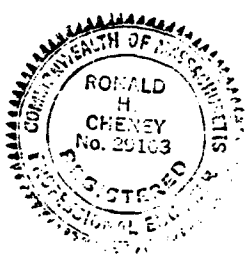
At 1/2 PMF the inflow would be 4,300 cfs. The outflow of 1,720 cfs passes the spillway. The reservoir is surcharged to elevation 740.4 or 0.2 feet below the dam crest.

Based on the visual inspection, the dam was in generally fair condition. However, due to the dense vegetation on the downstream slope, apparent seepage in this area could not be adequately inspected. This combined with apparent settlement along the upstream slope and the probable presence of root systems within the embankment give the overall rating of the dam as poor. The dike was found to be in generally good condition. It is recommended that the Owner retain the services of a qualified registered professional engineer to investigate the following: Soft, wet areas at the downstream toe of the dam including pooled water within the spillway channel; seepage existing around the outlet pipes and through the walls of the outlet channel; settlement of the upstream slope at the crest of the dam; determine a means for removing tree and bush roots from the dam and dike including selecting acceptable backfill for holes caused by root removal; perform a detailed hydrologic/hydraulic investigation to determine overtopping potential and need for increasing spillway capacity.

The Owner should institute remedial measures which include: brush growing on and up to 150 feet downstream of the dam should

be removed to permit inspection; the brush growing on the dike should be cut; the walls of the outlet channel should be repaired; bushes growing in the spillway channel should be cut and new growth cut every year; the spillway channel floor and walls should be repaired; grass should be planted on the crest of the dam to prevent erosion; the broken handrail on the access bridge should be repaired; a formal system should be developed for monitoring the project during and just after periods of high precipitation and to warn downstream residents in case of an emergency; the dam and dike should be inspected every year, by a qualified registered professional engineer who can identify conditions of concern which if left unchecked could jeopardize the safety of the dam; establishment of a formal operational procedure and maintenance program for the dam and dike.

These above recommendations and remedial measures should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.



Ronald H. Cheney, P.E.
Vice President

Hayden, Harding & Buchanan, Inc.
Boston, Massachusetts

This Phase I Inspection Report on Notown Reservoir Dam & Dike has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to

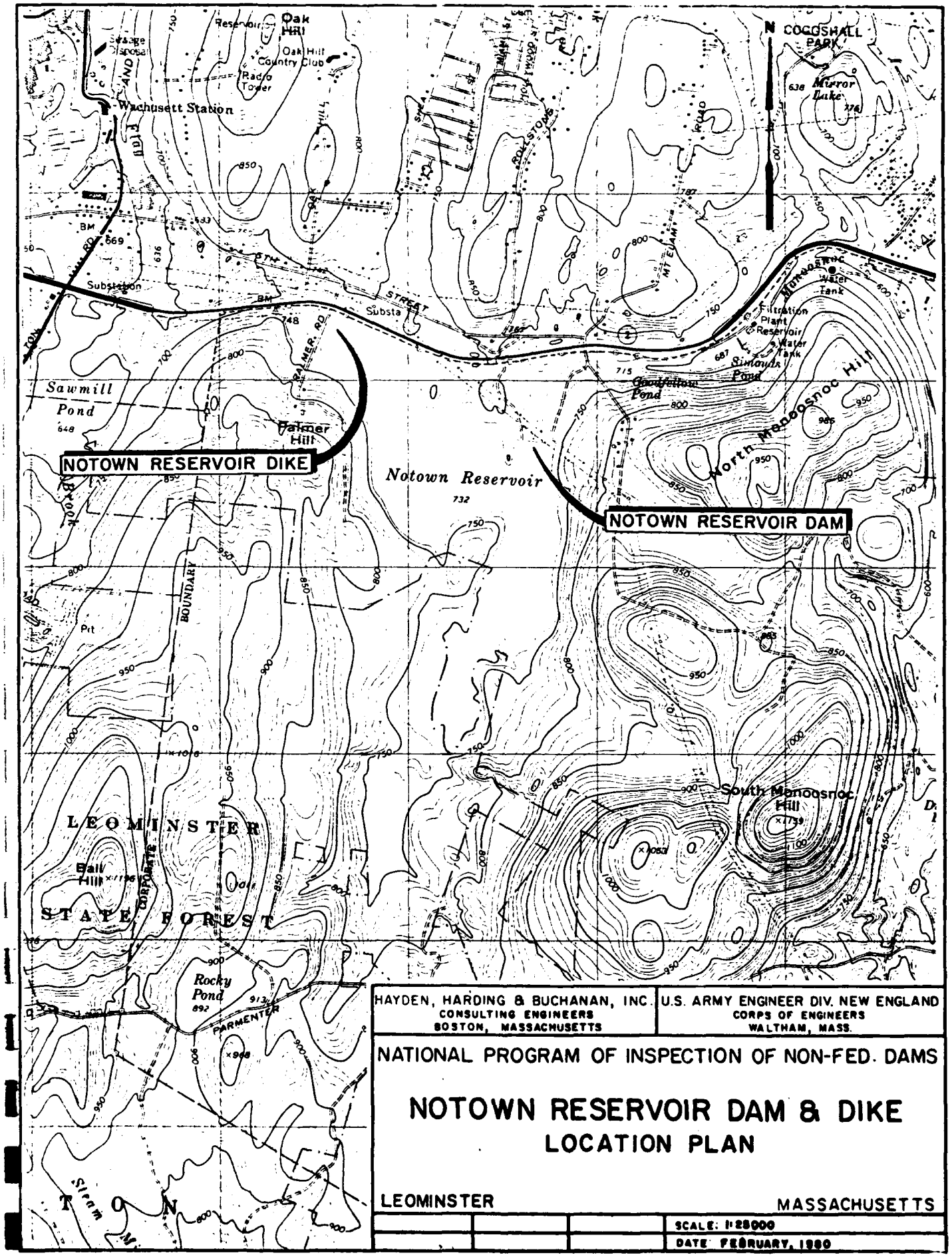
assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

APPENDIXES



HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

NOTOWN RESERVOIR DAM & DIKE
LOCATION PLAN

LEOMINSTER MASSACHUSETTS

SCALE: 1:25000

DATE FEBRUARY, 1980

PHASE I
NATIONAL DAM INSPECTION PROGRAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Hayden, Harding & Buchanan, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued Hayden, Harding & Buchanan, Inc. under a letter of 24 October 1979 from William E. Hodgson Jr., Colonel, Corps of Engineers. Contract No. DACW 33-80-C-0006 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

Notown Reservoir Dam and Dike are located in the City of Leominster, in Worcester County Massachusetts. The reservoir is formed by the waters of several small streams. Notown Reservoir Dam is located in the northeastern portion of the reservoir with the Dike located in the northwest section just east of Palmer Road. The dam and dike are shown on the Fitchburg, Massachusetts Quadrangle with the dam having the approximate coordinates North 42°32'30", West 71°49'01" and the dike having the approximate coordinates of North 42°32'46", West 71°49'41".

b. Description of Dam and Appurtenances

Notown Reservoir Dam is a 21 foot high (hydraulic height), 600± foot long earth embankment having a concrete intake structure and an emergency spillway. The embankment has a crest width of 16± feet and a riprapped upstream slope on approximately 3H:1V. The downstream slope is turf lined and has an approximate slope of 2H:1V. In 1930, modifications along the length of the upstream side slope were made. These included driving a sheet piling into the underlaying clay strata, pouring a concrete cap atop the sheet piling, paving the existing riprap with concrete and constructing an upper 6 foot high concrete cutoff wall. The intake structure is a 9 foot by 10 foot by 19± foot high concrete structure, see photograph 1. It has 2 gated inlets of unknown size, which outlet into two 24 inch cast iron pipes. These discharge into an outlet channel approximately 75 feet downstream

of the intake structure, photograph 2. The channel, photograph 3, extends approximately 250 feet downstream, before it converges with the outlet channel from the emergency spillway. Both channels have concrete and stone masonry side walls.

The emergency spillway, photographs 4 and 5, is approximately 49 feet long at the spillway crest. The weir has a 1.5± foot high concrete sill with provisions for 8 inches of flashboard. The elevation of the concrete sill is approximately 5.5 feet below the crest of the dam. The spillway has stone masonry, concrete covered training walls. The spillway outlet channel is stepped and has stone masonry concrete lined sidewalls which extend approximately 300 feet downstream where it converges with the intake structure outlet channel. Shortly downstream of the convergence of these channels, the stone masonry sidewalls end.

Notown Reservoir Dike is a 13 foot high (hydraulic height), 750± long earth fill embankment. It has no intake structures or spillway. The 1894 Plans indicate the embankment to be composed of gravel and to contain a 1'-5" to 2 foot thick mortared stone masonry corewall extending to within 1.5 feet of the crest. The downstream slope and crest of the dike are turf lined. The upstream slope has a riprap lining up to the high water level. The crest has a typical width of 16 feet. The downstream side slope was measured to be at approximately 2H:1V and the upstream side slope was measured at approximately 3H:1V, above the water surface.

c. Size Classification

The dam and dike have a size classification of intermediate based upon the storage capacity of 3,900 acre-feet, and hydraulic heights of 21 feet and 13 feet, respectively.

d. Hazard Classification

The dam and dike have high hazard classifications. Based on Corps Guidelines, the assumed dam and dike failure flows will be 17,835 cfs and 12,600 cfs, respectively. The dam contains the spillway which will have caused base flow flooding in the downstream areas prior to dam failure due to its discharge of 1,850 cfs.

Dam failure flooding will cause flood stages two to twenty feet deep, including base flood stage levels. At least 34 homes, a water treatment plant and several roads will be damaged by failure flood water depths of at least four feet. Base flow flooding will damage about 15 homes with about two feet of water. Loss of life due to dam failure is possible.

Dike failure flooding stages will reach depths of five to 30 feet. At least 14 homes, several roads and a large manufacturing plant will be damaged by flood water depths of two to 30 feet. Loss of life due to dam failure is possible.

e. Ownership

The dam and dike have always been owned by the City of Leominster.

f. Operator

The dam and dike are operated and maintained by the City of Leominster Water Department. Mr. Archie Descaronis is the designated caretaker. The mailing address is 109 Graham St.,

Leominster, Massachusetts 01453. The telephone number is (617) 534-6420.

g. Purpose of Dam

The purpose of the dam has always been water supply for the City of Leominster.

h. Design and Construction History

The original dam was probably completed prior to 1876. Plans dated 1930 indicate the rubble cut-off to be "as shown on plan of J.W. Gates 1876." Plans dated 1894, indicated the dam, spillway and dike to be raised by approximately 1.5 to 3 feet. The engineer indicated on these plans is George Raymond. In 1930 and 1931, the upstream side slopes of the embankment were modified, by installing a steel sheet piling wall with a concrete cap along the length of the embankment, grouting the existing riprap with concrete and pouring an upper 6 foot high concrete corewall. The engineering firm of Metcalf and Eddy, Boston, Massachusetts is indicated on the 1930 plans.

i. Normal Operational Procedure

Notown Reservoir is located approximately one mile upstream of the City of Leominster Water Filtration Plant. The caretaker visits the dam at least once a day and regulates the reservoir discharge to the plant from the intake structure at Notown Reservoir. The quantity of water is determined, based on the demand within the system. The valves for the intake structure are usually operated about 1/3 open, or less. Normally there is 8 inches of flashboard in place at the spillway. The reservoir water level is normally below the spillway crest.

1.3 Pertinent Data

a. Drainage Area

The drainage area 4.57 s.m. (2,925 acres) is basically wooded, undeveloped land. Over half of the drainage area is within Leominster State Forest. A small amount of developed land occurs to the north of Route 2. A very small percentage of the drainage area is comprised of ponds or swamps.

There are several small brooks which carry runoff to the reservoir. See drainage area map in Appendix D, and photographs in Appendix C.

b. Discharge at Damsite

1. Outlet Works

The outlet works are two 24 inch diameter cast iron pipes (photographs 2 and 3). These are controlled at the intake structure (photographs 4 and 7) by manually operated valves. At the toe of the dam, these pipes discharge into an outlet channel. The invert elevation is 719.5, at the outlet. When fully open and with the reservoir water surface level at elevation 735±, spillway crest, these pipes could be discharging a total flow of 150± cfs. These valves are usually operated about 1/3 open, or less.

2. Maximum Known Flood at Damsite

Inspection reports from the Worcester County Engineers Office indicate that in 1936, 1938 and on March 10, 1958, the level of water was 12± inches, 4± inches and 4± inches in the spillway. The corresponding discharges are 176± cfs, 50± cfs and 50± cfs. These were observed maximum levels and could have been exceeded.

United States Weather Bureau records indicate that during September 17 to 22, 1938 and August 17 to 20, 1955, about 9 inches and 6 inches, respectively, of rainfall occurred near the project location.

3. Ungated and Gated Spillway Capacity at Top of Dam

The spillway has no gates but has provisions for 8 inches of flashboards (photographs 5 and 6). Total spillway discharge, with water at elevation 740.6, top of dam, is about 1,850 and 1,960 cfs with and without flashboards, respectively.

4. Ungated and Gated Spillway Capacity at Test Flood Elevation

The test flood (PMF) will surcharge the reservoir to elevation 741.5±, assuming 8 inches of flashboards are used. The discharge is 5,070 cfs. The dam and dike are overtopped by 0.9 feet.

With the 8 inches of flashboards removed, the spillway capacity is increased by 110 cfs (1,960-1,850). This increase has a negligible effect on the overtopping potential under the (PMF) test flood. The dam and dike will still be overtopped by 0.9 feet.

5. Total Project Discharge at Top of Dam

With the water level at elevation 740.6, top of dam, the total project discharge would be about 1,890 cfs. This assumed both 24 inch pipes are one third open and flashboards are in place.

6. Total Project Discharge at Test Flood Elevation

The total project discharge with water at the test flood level and the 24 inch pipes one third open would be about 5,110 cfs.

c. Elevation (ft. above NGVD - Metcalf & Eddy approximate only)

(1) Streambed at toe of dam ---------- 719.5±

(2) Bottom of cutoff ---------- 710± (Metcalf & Eddy plans 9-5-30)

(3) Maximum tailwater ---------- 725±

(4) Normal pool ---------- 732.0±

(5) Full flood control pool ---------- N/A

(6) Spillway crest (with flashboard) ---------- 735.8±
(without flashboard) ---------- 735.2±

(7) Design surcharge (Original Design) -------- Unknown

(8) Top of dam and dike ---------- 740.6

(9) Test flood surcharge ---------- 741.5

d. Reservoir (Length in feet)

(1) Normal pool ---------- 5,500

(2) Spillway crest pool ---------- 5,500

(3) Test flood pool ---------- 6,100

(4) Top of dam ---------- 6,000

(5) Flood control pool ---------- N/A

e. Storage (acre-feet)

(1) Normal pool ---------- 1,900
elevation 732±

(2) Spillway crest pool ---------- 2,500±

(3) Top of dam ---------- 3,900±

(4) Test flood pool ---------- 4,300±

(5) Flood control pool ---------- N/A

f. Reservoir Surface (acres)

(1) Normal pool ---------- 200

(2) Spillway crest ---------- 230

(3) Test flood pool ---------- 340

(4) Top of dam ---------- 315

(5) Flood control pool ---------- N/A

g.	Dam	Dike
(1)	Type - earth, gravity	earth, gravity
(2)	Length - 600'±	750'±
(3)	Height - 21'±	13'±
(4)	Top Width - 16'±	16'±
(5)	Side Slopes - 2:1 d.s., 3:1 u.s.	2:1± d.s., 3:1± u.s.
(6)	Zoning - Unknown	Unknown
(7)	Imperivous Core - Unknown	masonry corewall
(8)	Cutoff - steel sheet piling u.s., 3 rubble and/ or brick cutoff walls along outlet pipes - 1930 plans	cutoff trench indicated
(9)	Grout curtain - Unknown	Unknown

(10) Other - grouted paving and concrete wall buried along u.s. face - 1930 plans of dam

h. Diversion and Regulating Tunnel - none at this project

i. Spillway

(1) Type - stone and concrete masonry overflow

(2) Length of weir - 49±

(3) Crest elevation - 735.15 without flashboards
735.8 with flashboards

(4) Gates - none

(5) U/S Channel - opens directly into reservoir

(6) D/S Channel - stone masonry - variable width, steep slope

j. Regulating Outlets

The only regulating outlets are the two 24 inch water supply discharge pipes. They are controlled manually with gate valves located at the intake structure. These pipes extend through the dam and discharge into an outlet channel. The outlet channel has masonry walls with gravel bottom of invert elevation 719.5. See photographs 2, 3 and 8. These pipes are usually operated 1/3 open or less.

SECTION 2

ENGINEERING DATA

2.1 Design Data

Plans dated 1894 and 1930 were located at the Worcester County Engineering Office. The 1894 plans indicated George Raymond as the engineer and show modifications to an existing dam and dike structure. The 1930 plans indicate Metcalf and Eddy as the engineer, and show further modifications to the dam. The 1930 plans contain a note which indicates the "cut-offs as shown on plan of J.W. Gates, 1876." These 1876 plans were not located. No design calculations for dam or dike were located.

2.2 Construction Data

No construction data pertaining to the 1876, 1894 or 1930 plans was located.

2.3 Operation Data

The caretaker regulates the outflow from the intake structure according to the demand within the system. There is no written formal operational manual for the dam or dike. The engineering firm of Coffin and Richardson of Boston, Massachusetts was retained by the City of Leominster in 1978 to evaluate all City owned dams, and prepare a report on existing conditions. Excerpts from this report dealing with Notown Reservoir Dam are presented in Appendix B.

2.4 Evaluation of Data

a. Availability

A limited number of plans as well as County Inspection Reports between the years 1924 and 1964, for the dam and dike,

were available at the Worcester County Engineering Office. No State Inspection Reports or indepth design calculations were located.

b. Adequacy

The lack of indepth engineering data does not allow for a definitive review. Therefore, the adequacy of this dam, structurally and hydraulically, cannot be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history, and sound engineering judgement.

c. Validity

The visual inspection of this facility showed no reason to question the validity of the majority of the information provided. The only exception is the elevation of the upper concrete corewall at the dam. The 1930 plans indicate the top of wall to be 2 feet below the crest of dam, while the field inspection indicated the top of wall to be at the top of dam.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General

At the time of inspection the level of the reservoir was approximately 7½ feet below the top of dam.

b. Dam and Dike

The reservoir is formed by a dam and dike located at opposite ends of the reservoir. On the existing plans, the dam and the dike are referred to as the east dam and west dam, respectively. The two features are described in the following sections.

1. Dam

The dam consists of an earth embankment with approximately 2H:1V downstream and 3H:1V upstream slopes.

A masonry spillway is located between the dam and the left abutment. Upstream of the dam there is a gatehouse which contains the controls for two 24 inch diameter outlet pipes. The outlet pipes pass through the dam and exit at the downstream toe of the dam where they discharge into an outlet channel.

Upstream Slope

The upstream slope of the dam is covered with riprap as shown in photograph 4. The upper 12 feet of the slope is protected by hand-placed flat stones while the remainder of the slope

that could be seen above and below the water level consists of bulky shaped riprap. The riprap is generally in good condition.

On the upper 12 feet of the upstream slope, the riprap stones are not placed closely together and soil and vegetation are visible between all the stones. The vegetation consists of grass and stumps of bushes that have been cut. As shown in photograph 14, the bushes were allowed to grow too long before they were cut, and substantial root systems have probably developed. Below the upper 12 feet of the upstream slope, the riprap stones are close together, and only a few areas of the slope have soil and vegetation visible between the riprap stones.

At about 95 feet left of the right abutment, the upstream slope apparently has settled below the edge of the crest, as shown in photograph 13. About 3 inches vertical settlement and 1-3/4 inches horizontal upstream displacement were observed.

A gatehouse is located upstream of the slope. A walkway spans from the gatehouse to the upstream slope where the walkway is connected to a concrete footing. The footing appears to have settled about 3 inches as shown in photograph 10.

Crest

The crest of the dam is about 16 feet wide and generally soil-covered as shown in photograph 7. The crest appears to be used as an access road by vehicles. Grass and bushes are growing next to the roadway on the downstream edge of the crest. On the upstream edge, a one foot wide strip of concrete extends along the entire surface of the crest. Existing plans for the dam

indicate that the exposed concrete is apparently the top of a concrete wall, which extends to a depth of 8 feet below the crest.

Downstream Slope

As shown in photographs 12 and 20, the downstream slope is covered with dense vegetation consisting of grass, bushes, and small trees. Apparent seepage areas with standing water were observed at the downstream toe at about 120 feet to the right of the outlet channel. The entire area downstream of the dam, as shown in photograph 21, was generally wet and swampy.

2. Dike

The dike consists of an earth embankment with an approximate 2H:1V downstream slope and 3H:1V upstream slope. There is no spillway associated with the dike.

Upstream Slope

The upstream slope is generally covered with riprap as shown in photograph 26. On the upper 10 feet of the upstream slope, grass and bushes are growing between the riprap stones as can be seen in photograph 26. The vegetation is relatively dense. In some areas of the slope there are large stumps remaining from bushes which were allowed to grow too large before they were cut. Below the upper 10 feet, there is only occasional vegetation. growing between the riprap stones.

The right abutment consists of the embankment for State Highway 2. The junction of the upstream slope and the right abutment is covered with large riprap stones up to about 4 feet in diameter as shown in photograph 26.

Crest

The crest of the dike is about 16 feet wide and is generally covered with grass, photograph 25. Trespassing by vehicles was evident.

Downstream Slope

As shown in photograph 30, the downstream slope is generally covered with dense vegetation consisting of grass and bushes. About 50 feet to the right of the left abutment there is a path which has been eroded about 6 inches below the surface of the downstream slope, photograph 29. Standing water was observed at the downstream toe about 100 feet to the right of the left abutment, as shown in photograph 28. The source of the water was judged to be due to surface runoff.

An asphalt paved roadway is located along the downstream toe. At about 150 feet to the left of the right abutment, a parking area has been cut into the toe of the dike between the roadway and the dike, photograph 30.

Downstream of the roadway is a swampy area as shown in photograph 27. Water is generally ponded over the entire swampy area downstream of the roadway. The source of this water was judged to be surface runoff.

c. Appurtenant Structures

Dam Spillway

The spillway which passes between the dam and the left abutment consists of a concrete weir with wooden flashboards on top, as shown in photograph 6. An insignificant amount of

vegetation is growing in the approach channel to the spillway. No water was flowing over the spillway at the time of the inspection.

Upstream of the spillway weir, the spillway training walls consist of dry masonry stone walls which have been pointed in some areas, photographs 4 and 6. The training walls downstream of the weir consist of mortared masonry stone walls covered with a thin layer of concrete, as shown in photographs 6 and 15. The concrete is spalling in some sections of the walls.

The metal frame concrete deck service bridge and the concrete intake structure are shown in photographs 1 and 4. The intake structure was observed to be in good condition. All control gates were reported operable. The service bridge was observed to be in good condition, however about 3 inches of settlement was observed at the bridge seat and one handrail post was broken. The control valves on the two 24 inch outlet pipes were about 1/8 open and the total discharge was about 7 cfs.

d. Reservoir Area

There are no indications of instability along the banks of the reservoir in the vicinity of the dam.

e. Downstream Channel - Main Dam

There are two downstream channels, one downstream from the spillway and the other downstream from the outlet pipes. The two downstream channels are referred to as the spillway channel and the outlet channel, respectively, in the following sections. The two channels join about 300 feet downstream of the dam.

Spillway Channel

The floor of the spillway channel is covered with riprap stones which were apparently placed by hand. As shown in photograph 16, approximately the first 200 feet of the channel is constructed in four approximately equally spaced steps. The areas of the channel between the steps are relatively flat, with a gradual slope downstream. Grass and small bushes are growing between the stones in some areas, and some stumps of cut bushes were observed.

The spillway channel is bordered on each side by mortared masonry stone walls covered with a layer of concrete. As shown in photograph 17, some sections of the walls are leaning toward the channel. Concrete is spalling in some portions of the walls.

A pool of water was observed on the floor of the spillway channel about 175 feet downstream from the spillway weir. The water may be due to seepage from the dam or a standing water swampy area.

Outlet Channel

The outlet channel is shown in photograph 8. The floor of the outlet channel is generally covered with gravel and cobbles. Water was flowing from the outlet pipes and down the outlet channel at the time of the inspection.

The outlet channel is bordered on both sides by stone walls covered with a layer of concrete. The concrete is spalling from the bottom of the walls generally along the entire length of the walls.

From the outlet pipes to about 145 feet downstream from the outlet pipes, water was observed seeping through the lower portion of the walls at several locations. Two examples of the seepage zones are illustrated in photographs 18 and 20. A seep was also observed to the left of the outlet pipes, as shown in photograph 2. In all the seepage zones, the surrounding stones were rust-colored and water was flowing.

3.2 Evaluation

Dam

The visual inspection indicated the dam to be in generally good condition. However, it is rated as poor based on the following:

The presence of soft, wet ground and standing water at the downstream toe of the dam may be a result of seepage conditions which, if not controlled, could lead to failure of the dam. Water seeping from around the outlet pipes of the dam is also a condition which if left uncontrolled could lead to failure of the dam. The source of seepage which exits into the outlet channel as far as 145 feet downstream of the toe of the dam must be investigated.

The horizontal and vertical movement observed on the crest of the dam and at the foundation for the control tower bridge indicate the presence of unknown conditions in the dam which could lead to slope failure if not corrected. The dam must be investigated to determine the cause of the observed movements.

The presence of a thick cover of grass and thorn bushes on the downstream slope of the embankment and at the toe makes it impossible to inspect the wet areas adequately. In view of the wet areas which can be seen, it is important that those areas be thoroughly investigated.

The presence of large root systems on the upstream and downstream slopes could create seepage paths which could lead to internal erosion of the dam.

The crest of the dam is susceptible to erosion since it is not covered with protective vegetation and the upper 12 feet of riprap provides a flat plane surface for waves to ride up to the crest during storms.

Dike

Visual inspection indicates the dike is in good condition.

Large brush and stumps and their root systems should be removed from the upstream face to prevent seepage paths leading into the dike.

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General

The caretaker regulates the outflow from the intake structure according to the demand within the system. The intake valves are normally operated about 1/3 open or less and the level of the reservoir is normally below the spillway flashboards.

b. Description of Warning System

There are no warning systems associated with this facility. However the downstream Water Filtration Plant is staffed 24 hours per day.

4.2 Maintenance Procedures

a. General

The City of Leominster Water Department is responsible for the maintenance of the dam and dike. There is no formal maintenance procedure.

b. Operating Facilities

The operational facilities are used on a daily basis. Any deficiencies which might develop in the operational facilities could be detected during normal operating procedures. There is no formal operational procedure for testing or repair of facilities.

4.3 Evaluation

There are no formal operational or maintenance procedures for the dam or dike. The outlet and spillway channel sidewalls and floors are in need of repair. Downstream slope vegetation should be cut and maintained. The dam and dike should be inspected every year by qualified registered professional engineers who can identify conditions of concern which, if left unchecked, could jeopardize the safety of the structure.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Notown Reservoir is located in the northeast section of the City of Leominster, near Route 2. The drainage area, 4.57 s.m. (2,925 acres), consists almost entirely of rolling, wooded undeveloped land, which includes several small swamp areas and one small pond. Over half of the drainage area is within Leominster State Forest. There are several small brooks which carry surface runoff into the reservoir. The reservoir has a surface area of about 200 acres at water elevation 732.

The reservoir outlet, Monoosnoc Brook, flows easterly about 2.3 miles to Pierce Pond (elevation 471) and developed areas of Leominster. It then flows about 1.5 miles further to reach Rockwell Pond (elevation 420±) and additional developed areas of Leominster. See Appendixes B, C, and D.

5.2 Design Data

The dam dates to 1876, and possibly earlier. Hydraulic/hydrologic design data was not located.

5.3 Experience Data

Inspection reports from the Worcester County Engineers Office indicate that in 1936, 1938 and in March 10, 1958, the level of water was 12± inches, 4± inches and 4± inches in the spillway. The corresponding discharges are 176± cfs, 50± cfs and 50± cfs. These were observed maximum levels and could have been exceeded.

United States Weather Bureau records indicate that during September 17 to 22, 1938, and August 17 to 20, 1955, about 9 inches of rainfall occurred near the project location.

5.4 Test Flood Analysis

The dam has an intermediate size classification and a high hazard potential. Based upon Corps Guidelines, the test flood would be the full PMF. The test flood inflow would be 8,600± cfs.

Assuming the reservoir was initially filled to spillway level (photograph 6) elevation 735.8, the test flood would surcharge the reservoir to elevation 741.5±. Water would be about 5.9 feet deep in the spillway (photograph 11), whose maximum depth is about 5 feet. The dam and dike are overtopped by 0.9 feet. A small section of Route 2, adjacent to the dike (less than 100 feet in length), is also overtopped by 0.9 feet. The outflow would be about 5,070 cfs. This assumes the 8 inch high flashboards are in use. The spillway has a maximum capacity of about 1,850 cfs at the top of dam, or 37 percent of the test flood outflow

The 4± foot deep stone masonry outlet channel (photograph 11) has a slope of 6 percent within the first 150 foot downstream reach. It will not be able to transport the test flood outflow without its channel banks being overtopped. About 150 feet further downstream, the channel enters Monoosnoc Brook and a relatively flat area, which leads to Goodfellow Pond.

Considering a flood equal to 1/2 PMF, the inflow would be 4,300 cfs. The outflow is 1,720 cfs, at the spillway. The reservoir is surcharged to elevation 740.4, but the dam and dike are not overtopped.

5.5 Dam Failure Analysis

Notown Reservoir has a main dam (photograph 3) and a dike (photograph 22). A failure analysis has been performed for each. Each failure will be discussed separately. See dam and dike failure impact maps shown in Appendix D.

Main Dam

The dam was assumed to have failed when the water level was at elevation 740.6, top of dam. Forty percent of a 275± foot long section of the 21 foot high dam was assumed to have failed. The peak failure discharge is 16,710 cfs. The main dam also contains the spillway which will be discharging a base flow of about 1,850 cfs prior to dam failure. This base flow will flood many downstream areas prior to dam failure.

The first impact area is at the power lines at station 1+00 (photograph 12). There, both base flow and failure flooding could damage the power line supports. Base flow flooding at least 3 feet deep or more could occur. Flood depths could reach 13 feet due to dam failure, including base flow stages.

The second impact area is at station 20+00. There, Route 2 and Parker Road are flooded. Both roads will be flooded by base and failure flows 3 and 10 feet deep, respectively. One home, to the north of Route 2 may receive 1 foot of damage by failure flood water.

The third impact area is at station 50+00, the water treatment plant. The plant is adjacent to the Brook and it will be flooded by 2 feet of base and 5 feet of failure flow. The first floor level of the plant appears to be above the flood level. The basement level will be affected.

The fourth impact area is between stations 80+00 to 110+00. From station 80+00 to 90+00, Route 2 and eleven homes are impacted. The base and failure flow will flood Route 2 with 3 and 9 feet of water, respectively. The water will overflow Route 2 and enter

the residential area to the north. Base flow will flood 5 homes with 2 feet of water. Failure flood stage will be six feet deep and flood an additional 6 homes with at least two feet of water.

Between station 90+00 to 100+00 no homes are in the base flow flood area. Failure flow will flood at least 23 homes with up to 4 feet of water. Failure flood stage is 3 to 5 feet.

From station 100+00 to 110+00 additional damage will occur. Base flow will flood about 10 homes with at least 2 feet of water. Failure flood stage will be six feet deep. An additional five homes will be flooded by at least 4 feet of water. Route 2 is also flooded in this area by base and failure flow.

Beyond station 110+00 there is a larger area of residential development which would be impacted by the remaining failure flow of 15,180 cfs and base flow conditions.

Dike

The dike was assumed to have failed with the water level at elevation 740.6, top of dike. Forty percent of a 400 foot section of the 13 foot high dike was assumed to have failed. The peak failure discharge is 12,600 cfs. Since the dike has no spillway there is no base flow flooding condition.

Within the first 1,000 feet downstream, several locations are affected by failure flooding (photograph 24). The flood stage could be at least 5 feet, depending on exact elevations. One residential structure could receive flood damage 2 feet deep. Route 2 and Oak Hill Road and one structure [illegible] flood

water damage of 5 feet or more. Failure outflow would flow westerly along the north side of Route 2 to a location near Sawmill Pond at station 30+00.

From station 10+00 to 30+00± the power transmission line could be damaged by failure flood water at least five feet deep.

At station 22+00 to 40+00 Route 2 is again flooded. Flood depths will vary from 5 to 8 feet. The affects of downstream flow restrictions will be seen in this area as an increase in flooding depth. A power substation and at least 13 homes will be flooded by water depths of 3 to 8 feet. Flood stage could reach 13 feet.

The road embankment of 5th Street and the large manufacturing plant would receive flood damage of 20 to 30 feet. A major flow restriction appears to occur at the manufacturing plant location which was constructed across the steep, narrow stream valley.

Beyond this area, additional flood damage can occur further downstream at industrial and residential areas as the remaining 5,600 cfs failure outflow continues downstream.

The possible failure of either the dam or dike would create a significant potential for loss of life.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual examination of the dam indicates the following structural problems:

a. Horizontal and vertical movement is evident on the crest of the embankment and at the foundation of the control tower access bridge. This movement indicates the presence of unknown conditions which could lead to a slope failure if not corrected.

b. The presence of soft, wet ground and standing water at the downstream toe of the dam may be the result of a seepage condition, which if not controlled, could lead to failure of the dam.

c. The presence of water exiting from the embankment around the outlet pipes could lead to internal erosion of the embankment.

Visual inspection of the dike did not indicate any immediate problems but the occurrence of large root systems on the upstream face of the dike could, if left unattended, result in seepage paths leading into the dike.

6.2 Design and Construction Data

The available data on the existing plans for the dam and dike are inadequate for analyzing the stability of the dam and dike.

6.3 Post Construction Changes

The 1894 plans indicate that the heights of the dam and dike were raised about 1.5 to 3 feet at some time after the original construction of the dam. In 1930 and 1931, the upstream side

slopes of the embankment were modified, by installing a steel sheet piling wall with a concrete cap along the length of the embankment, grouting the existing riprap with concrete and pouring an upper 6 foot high concrete corewall.

6.4 Seismic Stability

The dam is located in Seismic Zone 2, and in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Assessment

a. Condition

Dam

The visual inspection indicated the dam to be in generally fair condition. However, it is rated as poor, based on the following:

The presence of soft, wet areas at the downstream toe may be the result of seepage which, if not controlled, could lead to internal erosion and failure of the dam. The water observed seeping from the embankment around the outlet pipes could also lead to failure of the dam. Large root systems present on the upstream and downstream slopes could, if not removed, create seepage paths which could lead to internal erosion of the dam.

The settlement observed on the crest of the dam and at the foundation of the control tower access bridge indicates the presence of unknown conditions in the dam which could lead to a slope failure if not corrected. The crest of the dam is also susceptible to erosion since it is not covered with protective vegetation.

The hydraulic/hydrologic analysis indicated the outlet works to be inadequate to pass the test flood outflow, resulting in the dam and dike being overtopped.

Dike

On the basis of visual inspection, the dike is judged to be in generally good condition. The large root systems on the upstream face of the dike could, if not removed, result in seepage paths leading into the dike.

b. Adequacy of Information

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection and sound engineering judgement.

c. Urgency

The recommendations presented in Section 7.2 should be implemented within one year after receipt of the report by the Owner.

7.2 Recommendations

The Owner should retain a qualified registered professional engineer to investigate and design required remedial measures for the following:

a. Soft, wet areas at the downstream toe.

b. Seepage exiting around outlet pipes in the dam.

c. Seepage exiting from the walls of the outlet channel.

d. Settlement of the crest of the dam and the observed movement of the access bridge seat.

e. Means for removing trees and brush roots from the dam and dike and selecting acceptable backfill for holes caused by root removal.

f. Pools of standing water in the spillway channel.

g. Perform a detailed hydrologic/hydraulic investigation to determine overtopping potential and need for increasing spillway capacity.

7.3 Remedial Measures

a. Operating and Maintenance Procedures

1. Brush growing on and up to 150 feet downstream of the dam should be cut to permit inspection of the area downstream of the dam.

2. Brush growing on the dike should be cut.

3. The outlet channel walls should be repaired.

4. Bushes growing in the spillway channel should be cut and new growth cut every year. The spillway channel floor and walls should be repaired.

5. Grass should be planted on the crest of the dam to prevent erosion on the crest.

6. The broken handrail post on the service bridge should be repaired.

7. A formal system should be developed for monitoring the project during and just after periods of high precipitation and to warn downstream residents in case of an emergency.

8. The dam and dike should be inspected every year by a qualified registered professional engineer who can identify conditions of concern which, if left unchecked, could jeopardize the safety of the dam.

9. The Owner should establish a formal operational procedure and maintenance program for the dam and dike.

7.4 Alternatives

There are no practical alternatives to the recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT No Town Reservoir Dam and Dike

DATE 10/24/79

TIME 900

WEATHER Cool, Scattered Showers

U.S. ELEV. 733+ U.S. - DN.S.

PARTY:

Note: Dike embankment inspected on November 5, 1979

1. Ron Cheney - HHB
2. Dave Vine - HHB
3. Mike Angieri - HHB
4. Dan LaGatta - GEI
5. Steve Whiteside - GEI
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam, Dike, Spillway, Outlet Structure and Channel	R. Cheney, D. Vine, M. Angieri	
2.	Dam, Dike - Geotechnical	D. LaGatta, S. Whiteside	
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam DATE 10/24/79

PROJECT FEATURE Dam Embankment NAME D. LaGatta, S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney

Structural

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	740.6± (top of dam)
Current Pool Elevation	733±
Maximum Impoundment to Date	2,850 acre-feet± (1936)
Surface Cracks	None observed
Pavement Condition	Unpaved crest
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Upstream slope at edge of crest appeared to have settled about 3-in. in some areas
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Erosion of downstream slope next to head wall for outlet pipes.
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Vehicles on crest, pedestrian path on downstream slope
Sloughing or Erosion of Slopes or Abutments	Erosion of downstream slope next to head wall for outlet pipes.
Rock Slope Protection - Riprap Failures	Good condition
Unusual Movement or Cracking at or Near Toe	None observed
Unusual Embankment or Downstream Seepage	Extensive wet areas downstream of downstream toe. Seepage through walls of outlet channel
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed
Vegetation	Trees, bushes and dense brush on downstream slope. Brush had been cut in some areas and stumps left in place.

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam and Dike DATE 10/24/79

PROJECT FEATURE Dike NAME D. LaGatta, S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney

Structural

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	740.6
Current Pool Elevation	733±
Maximum Impoundment to Date	2,850 acre-feet± (1936)
Surface Cracks	None observed
Pavement Condition	Unpaved crest. Paved road at toe of dam in poor condition.
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Pedestrian and vehicle paths on downstream slope.
Sloughing or Erosion of Slopes or Abutments	Erosion (6-in. deep) along path on downstream slope about 50ft righ of left abutment.
Rock Slope Protection - Riprap Failures	Riprap in good condition
Unusual Movement or Cracking at or Near Toes	None observed
Unusual Embankment or Downstream Seepage	Extensive surface water downstream of roadway. Probably accumulated runoff.
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None observed
Vegetation	Trees, bushes and dense brush on upstream and downstream slopes. Brush had been cut in some areas and stumps left in place.

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam DATE 10/24/79

PROJECT FEATURE Intake Structure NAME D. LaGatta, S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney

Structural

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Unable to observe due to water level.
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	The concrete intake structure was observed to be in good condition.
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam DATE 10/24/79

PROJECT FEATURE Control Tower NAME D. LaGatta, S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney

Structural

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	good
Condition of Joints	good
Spalling	none observed
Visible Reinforcing	none observed
Rusting or Staining of Concrete	none observed
Any Seepage or Efflorescence	none observed
Joint Alignment	none observed
Unusual Seepage or Leaks in Gate Chamber	gates were open and in use
Cracks	none observed
Rusting or Corrosion of Steel	none observed
b. Mechanical and Electrical	all gates manually operated
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam DATE 10/24/79

PROJECT FEATURE Transition & Conduit NAME D. LaGatta. S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney
Structural

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	No transitions or conduits.
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam DATE 10/24/79

PROJECT FEATURE Outlet Structure NAME D. LaGatta, S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney

Structural

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Structure	Masonry wall at pipe outlets. Seepage observed at one pipe.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	None observed
Channel	Bottom covered in gravel and cobbles bordered by stone and concrete walls
Loose Rock or Trees Overhanging Channel	None observed
Condition of Discharge Channel	Good

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam DATE 10/24/79

PROJECT FEATURE Spillway NAME D. LaGatta, S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney, M. Angieri

Structural

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	good
Loose Rock Overhanging Channel	some small trees and brush
Trees Overhanging Channel	no
Floor of Approach Channel	stone covered with gravel and silt
b. Weir and Training Walls	
General Condition of Concrete	fair
Rust or Staining	none
Spalling	none observed
Any Visible Reinforcing	none
Any Seepage or Efflorescence	none
Drain Holes	None observed
c. Discharge Channel	
General Condition	fair
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	Some trees overhanging channel
Floor of Channel	Covered in riprap, stepped configuration, brush growth, some settlement
Other Obstructions	Stumps from cut brush

PERIODIC INSPECTION CHECKLIST

PROJECT No Town Reservoir Dam DATE 10/24/79

PROJECT FEATURE Service Bridge NAME D. LaGatta, S. Whiteside

DISCIPLINE Geotechnical NAME R. Cheney, D. Vine

Structural

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	generally good condition
Anchor Bolts	none observed
Bridge Seat	good condition
Longitudinal Members	good condition
Underside of Deck	good condition
Secondary Bracing	good condition
Deck	good condition
Drainage System	none
Railings	one post broken loose
Expansion Joints	none observed
Paint	fair condition
b. Abutment & Piers	
General Condition of Concrete	good
Alignment of Abutment	good
Approach to Bridge	good
Condition of Seat & Backwall	settlement at dam seat about 3"±

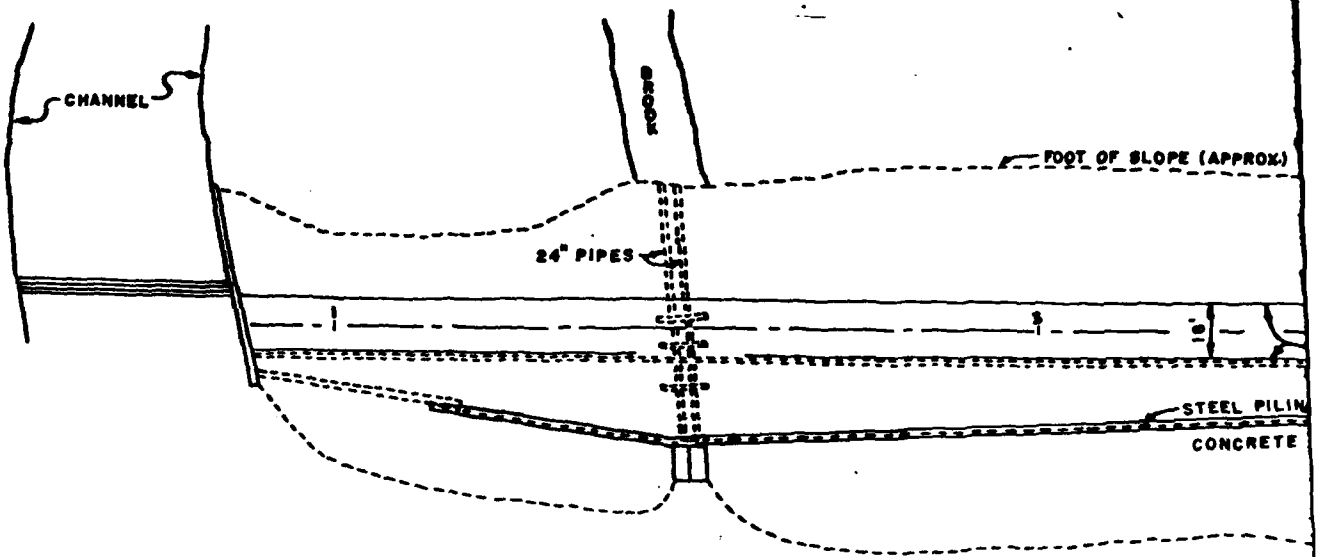
APPENDIX B

ENGINEERING DATA

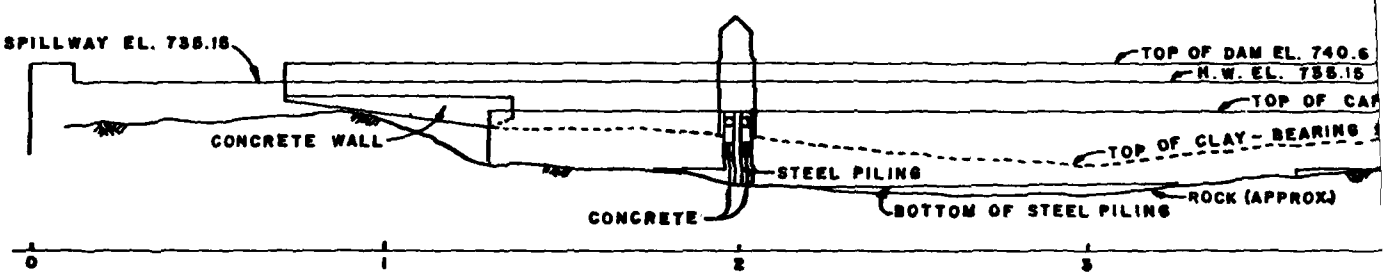
LIST OF ENGINEERING DATA

1. Design Plans dated 1894 and 1930 and County Inspection Reports between the years 1924 and 1962 were made available at the Worcester County Court House, Engineering Office, Worcester, Massachusetts.

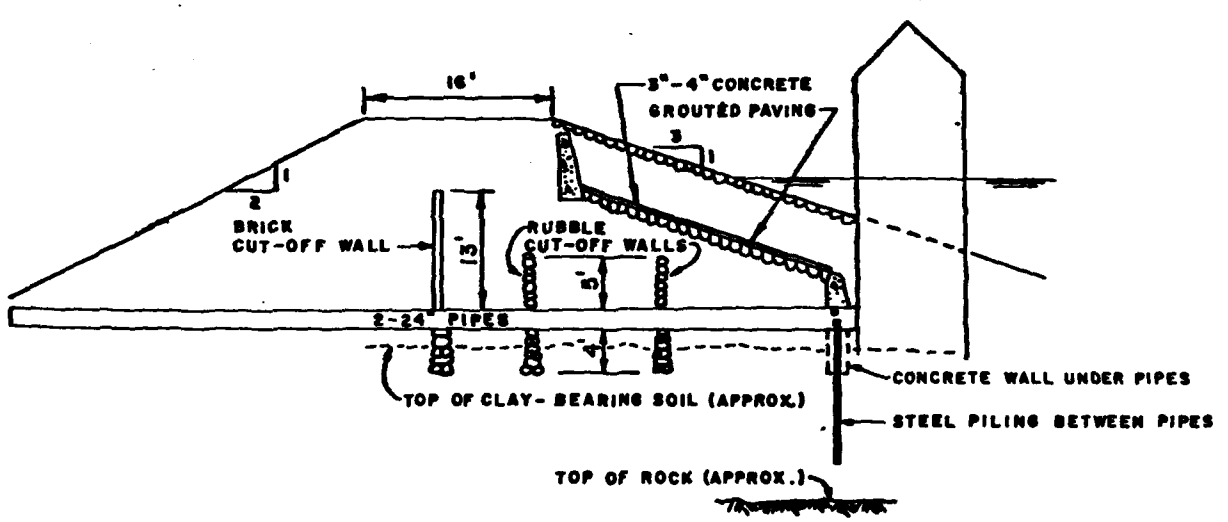
2. The Coffin and Richardson Report, evaluating the dams owned by the City of Leominster, was made available by the City of Leominster, Engineering Department, Leominster, Massachusetts.



PLAN

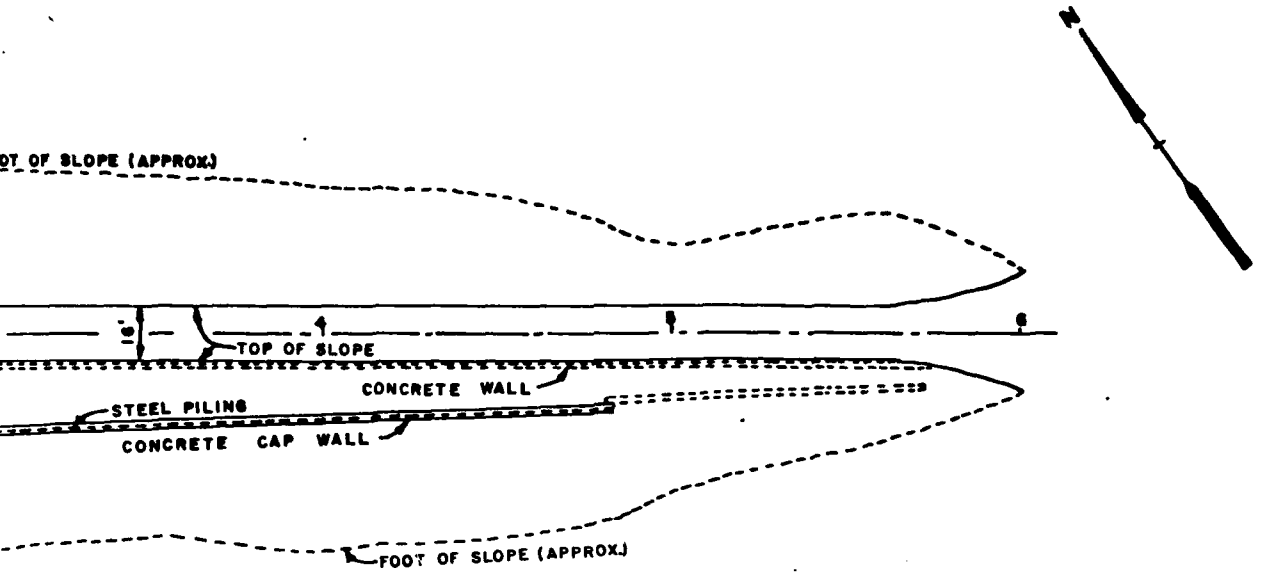


PROFILE

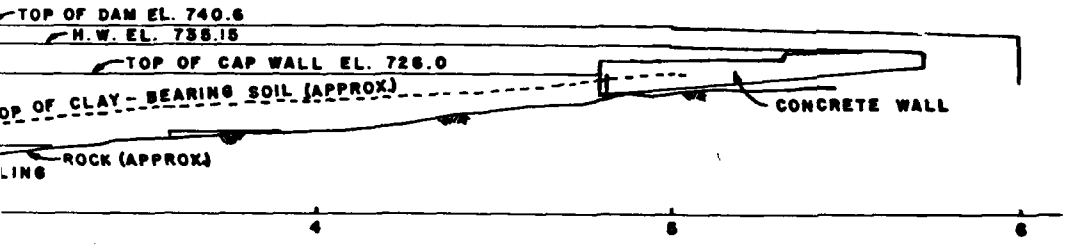


SECTION THROUGH OUTLET PIPES

NOTE:
TAKEN FROM PLANS OF
DATED SEPT. 8, 1938



AN



ILE

OTE:
AREN FROM PLANS OF MEDCALF & EDDY ENGINEERS
ATED SEPT. 5, 1980

N

HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

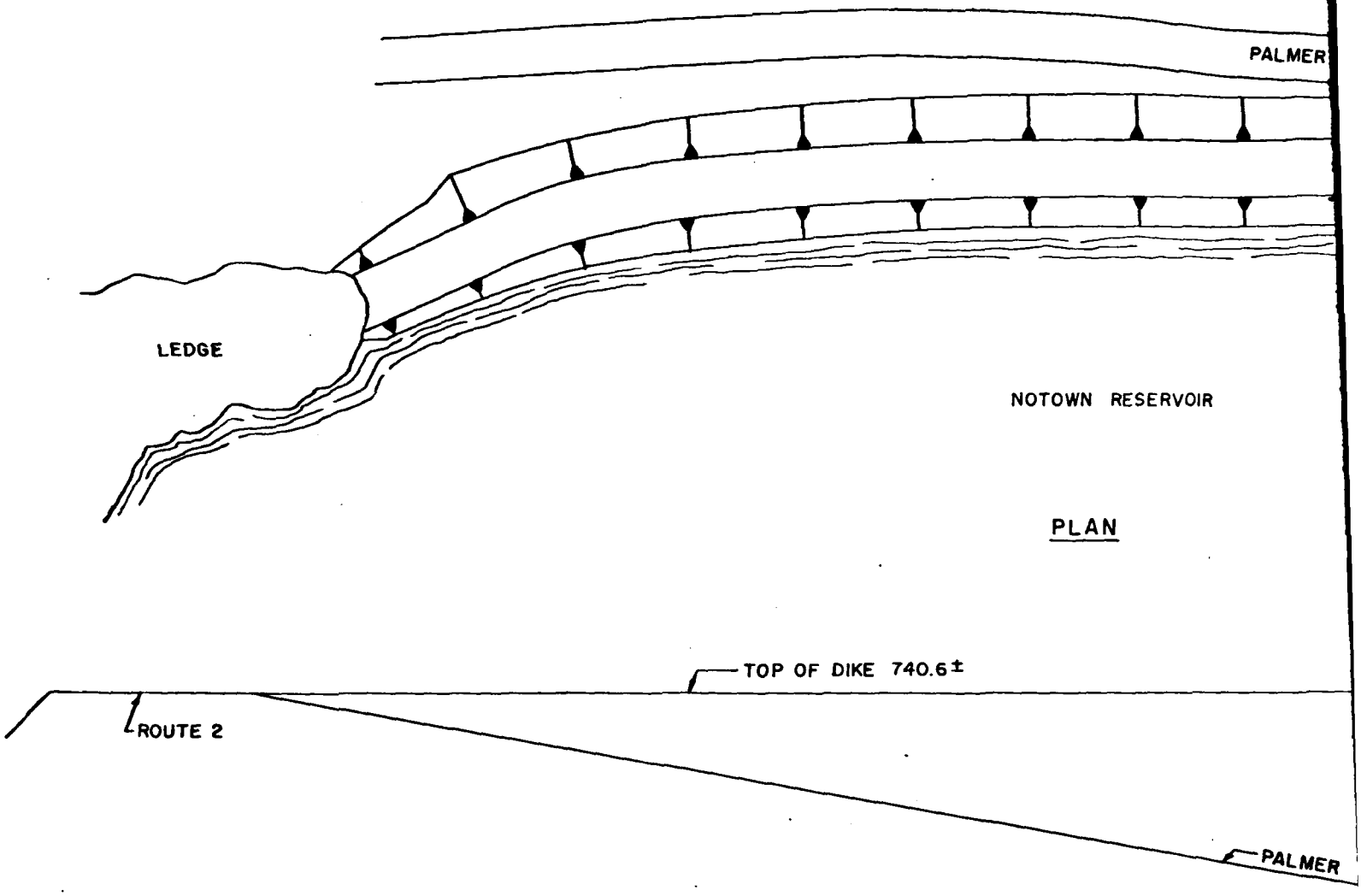
NOTOWN RESERVOIR DAM

PLAN, PROFILE & TYPICAL SECTION

LEOMINSTER - MASSACHUSETT

SCALE: NOT TO SCALE

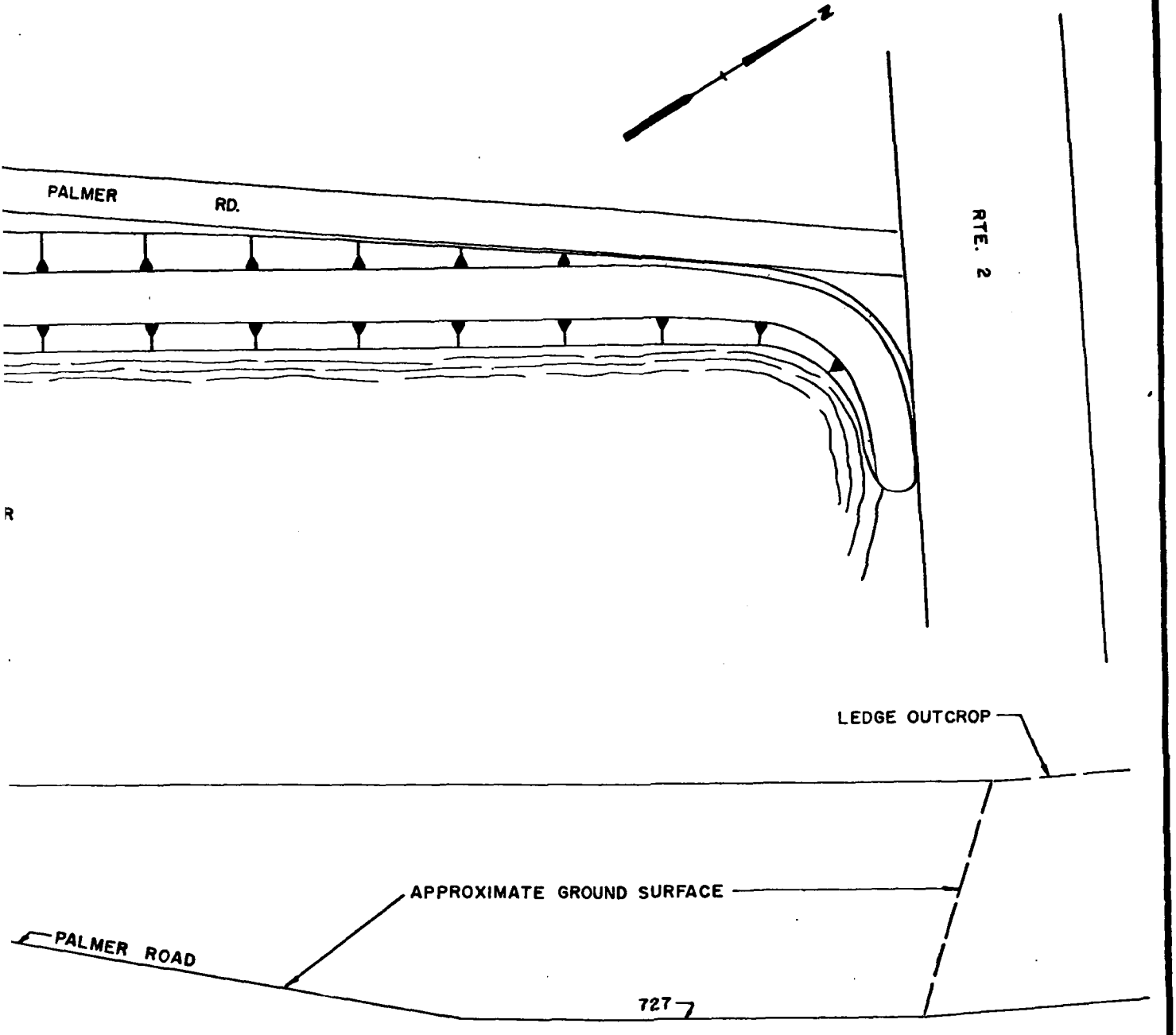
DATE FEBRUARY, 1980



PLAN

DOWNSTREAM ELEVATION

NOTE:
ELEVATION VIEW FROM US
PLAN VIEW FROM DRAWING



VIEW FROM USGS MAP & FIELD INSPECTION
FROM DRAWING BY G. RAYMOND C.E. SEPT. 1894

HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

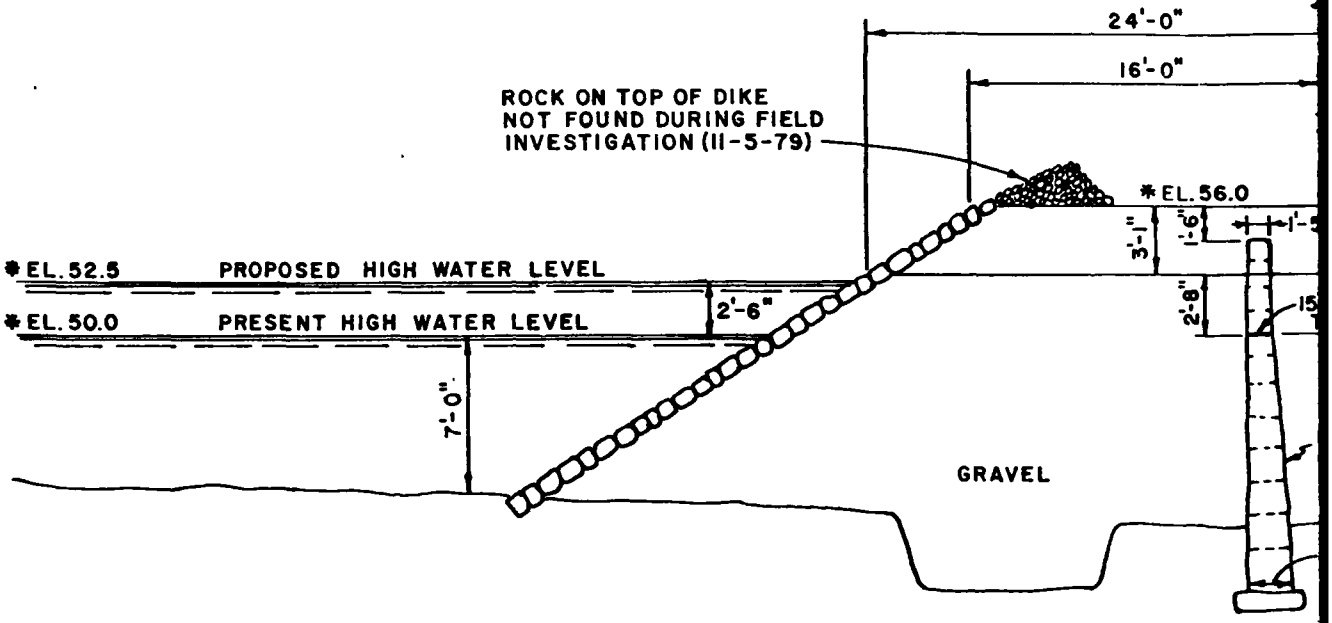
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

NOTOWN RESERVOIR DIKE
PLAN & ELEVATION

LEOMINSTER MASSACHUSETTS

SCALE: NOT TO SCALE

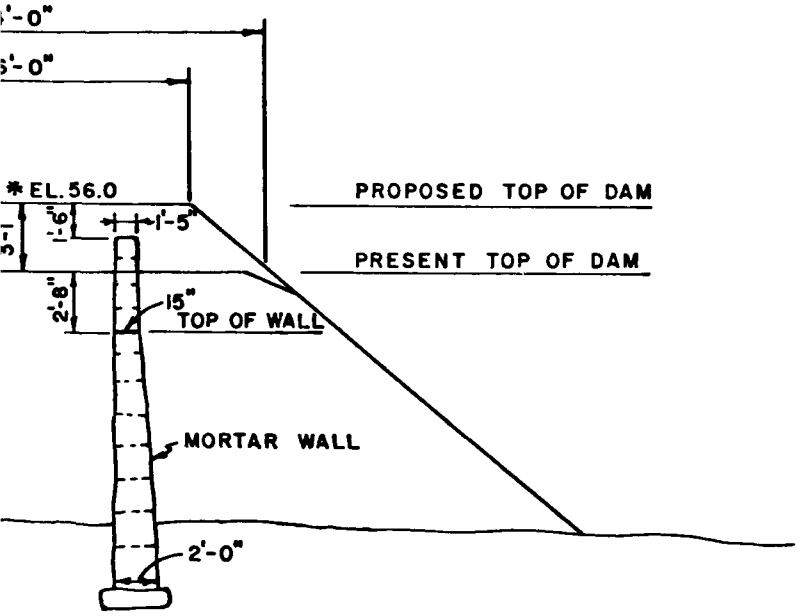
DATE FEBRUARY 1980



* DATUM UNKNOWN

CROSS SECTION

NOTE:
TAKEN FROM PROPOSED DIKE MODIFICATIONS WORCES
ENGINEER DEPARTMENT DWG. DATED OCT. 9, 1894



ON

ONS WORCESTER COUNTY
9, 1894

HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U S ARMY ENGINEER DIV NEW EN CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. D

NOTOWN RESERVOIR DIKE

CROSS SECTION DIKE

LEOMINSTER MASSACHUSET

SCALE: NOT TO SCALE

DATE FEBRUARY, 1980

TOWN Leominster DAM NO. 26-12

LOCATION Southerly of Rte 2 STREAM Monoosnoc Brook

"Notown Reservoir"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by City of Leominster Place Water Dept. Use Water supply

Inspected by WJK Date Sept 1964

Type of Dam Earth, stone and concrete Condition Fair - good

SPILLWAY

Flashboards in Place 8" of boards Recent Repairs

Condition The spillway is located at the westerly end of the dam.

Repairs Needed The downstream abutment walls are 12" thick concrete. The upstream walls are stepped cut granite stone. The crest is concrete. The upstream

EMBANKMENT

Recent Repairs easterly wall is bulged (out of line) The water level is

Condition very low. The embankment and spillway are covered

Repairs Needed with small brush.

GATES

Recent Repairs

Condition The gate platform has been fenced in. The

Repairs Needed gate is open.

LEAKS

How Serious No leaks.

DATE: County Engineer

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L. O. Marden Date Nov. 14, 1924 Dam No. 26-12

Town Leominster Location above Goodfellow Dam Fitchburg

Owner City of Fitchburg Use water supply

Material and Type Earth dam - granite masonery spillway

Dam Designed by Constructed by Year

SPILLWAY LRNGTH 50

El. top Abutment 100 El. Crest 95 El. Apron El. Streambed 76.5

Width top Abutment 20 Width top Crest 20 Width bottom Spillway 80 widest part

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition good

EMBANKMENT LENGTH500

El. Top 100 El. Natural Ground 78 Width Top 20

Width of Bottom 80 Upstream Slope 1½:1 earth Downstream Slope 1½:1

Kind of Corewall Riprap downstream

Material in Embankment Foundation

Condition good

GATES Location near C.L. of dam

Size 2 30" c.i. pipe Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure none

Recent Repairs and Date none

Topography of Country below Dam wooded rough

Nature of Buildings and Roads below Dam none immediatly below

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet B-7

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O.Marden Date Dec.10,1298 Dam No. 26-12

Town Leominster Location

Owner Leominster Water Works. Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition O.K.

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition embankment being widened-downstream slope increased to abt 2:1 upstream slope should be widened in spring- removing riprap and replacin make at least 1½:1.

GATES Location

Size Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure downstream side embankment about 50' from gate house- no move ment of water. Mr. Classon states this is not leak, but back water.

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.C.M. Date 8-9-30 Dam No. 16-38

Dam #2 on Whitney.

Town Leominster Location No. Town Res.

Owner Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY—Length Feet. Depth Feet

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition

EMBANKMENT—Length overall Feet

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition driving core of steel sheeting & capping with concrete

GATES Location

Size Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number of Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

B-9

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by LCM-Classon-Rockwell Date 8-22-30 Dam No. 15-38 43

Dams in Fitchburg

Town Leominster Location No Town Res.

Owner Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY—Length Feet. Depth Feet

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition

EMBANKMENT—Length overall Feet

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition constructing core of interlocking steel sheeting in upstream side of emb-& paving upstream slope with reinforced concrete -according to direction LCM.

GATES Location

Size Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number of Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet B-10

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O.Marden & G. Classon. Date Dec.7,1932 Dam No. 26-12 & 26-7

Town Leominster Location No Town Reservoir.

Owner Leominster Water Dept. Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY—Length Feet. Depth Feet

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition O.K.

EMBANKMENT—Length overall Feet

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition O.K. West dyke completely reconstructed in a very creditable manner.

GATES Location

Size Kind El. Flowline

Condition None at west dyke.

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure None visible.

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number of Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet B-11

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

40

Inspected by L.O.Marden-Guy Classon Date June 27,1935 Dam No. 16-37

Town Fitchburg Location No Town Reservoir.

Owner Leominster water Dept. Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition concrete side walls to wasteway below dam

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition filled in land below embankment- grassed over- no leaks visible.

GATES Location

Size Kind El. Flowline

Condition OK

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure none visible.

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet 5-12

WORCESTER COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs

Inspected by B. P. St. John Date 10-10-38 Dam No. 26-12

Town Leominster Location

Owner Leominster Water Dept. Use

SPILLWAY Earth H.W. 4" over crest in 1936 - 22" over crest

El.top Abutment 100 El.Crest 5.00 El.Apron El.St.Bed

Width top Abut. 1' Width top Crest 2' Width bottom Sp.way

Width flashboards Kind Flashboards

El.Flowline Cleanout Pipe Size and Kind Pipe

Kind of Foundation under Spillway

Condition good

EMBANKMENT

El.Top El.Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall steel conc.capped with cement Riprap stone

Material in Embankment Foundation

Condition good

GATES 2 Location

Size 24" Kind El.Flowline

Condition good

Evidence of Leaks in Structure none

Recent Repairs and Date 1930 and 1931 rebuilt and repaired

Number Acres in Pond Drainage Area in Sq.Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by E. C. Corcoran Date 10/10/34 Dam No. 16-40

Mr. Classon

Town Fitchburg Location Notown Reservoir

Owner Leominster Water Dept Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY 1' during flood Newer - Cement

El. top Abutment El. Crest All below Abt. El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried None Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition Good Water was 5 ft below spillway at start of heavy rain. This probably prevented serious damage in Leominster

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition Good

GATES Good Location

Size Kind El. Flowline

Condition

1 Gate opening flood to regulate river flow

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet 0.14

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by E. C. Carroran Date Dec. 12, 1942 Dam No. 26-12

Town Leominster Location No. Town

Owner City of Leominster Use Reservoir

Material and Type Earth Construction Concrete Core Wall Interlocking Sheet Steel Piling - top covered with concrete Dam Designed by with concrete slope on back. Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried 6" Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition No. Water over Spillway - Water is seeping under stone paving about 30' below toe of spillway - Condition Good.

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Concrete Riprap

Material in Embankment Earth. Foundation

Condition Good - Concrete wall along embankment apparently new construction - Possibly constructed this year.

GATES Location

Size Kind El. Flowline

Condition Good. - Open

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet 70-15

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.A.M. Guy Glass Jr. Date 10-28-93 Dam No. 26-12

Town Leominster Location No Town Rd

Owner " W.D Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition Fair - In 1936 - 23" on Concrete crest

" 1938 -

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition Fair - with rock in good shape

GATES Location

Size Kind El. Flowline

Condition Fair

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure Some Seepage

Recent Repairs and Date None

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet 710,000,000

T-16

TOWN Leominster DAM NO. 26.12

LOCATION No Town Res. STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT

WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Leominster Water Dept. PLACE Leominster USE Water supply

INSPECTED BY LOM Supt. Damon DATE Jan.18,1949

TYPE OF DAM Earth- steel cutoff emb-stone spill CONDITION good

SPILLWAY

FLASHBOARDS IN PLACE none RECENT REPAIRS none

CONDITION cut brush from channel- check over paving

REPAIRS NEEDED " " " " " " "

EMBANKMENT

RECENT REPAIRS None

CONDITION Good keep brush cut off

REPAIRS NEEDED None

GATES

RECENT REPAIRS None

CONDITION appears OK

REPAIRS NEEDED None

LEAKS

HOW SERIOUS none visible

DATE

COUNTY ENGINEER

TOWN Leominster DAM NO. 26-12

LOCATION Old Town Reservoir STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT

WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Leom. Water Dept PLACE Leom USE

INSPECTED BY DATE

TYPE OF DAM CONDITION

SPILLWAY

FLASHBOARDS IN PLACE RECENT REPAIRS

CONDITION

REPAIRS NEEDED

EMBANKMENT

RECENT REPAIRS

CONDITION

REPAIRS NEEDED

GATES

RECENT REPAIRS

CONDITION

REPAIRS NEEDED

LEAKS

HOW SERIOUS

DATE

COUNTY ENGINEER

26-12

WORCESTER COUNTY ENGINEERING DEPT.

WORCESTER, MASS.

DATE

SUBJECT: Flood Patrol

TO by Crocker Burbank Co. - employee.

26-12 Woodbury Dam.

Mar 1, 1958 Water 3 1/4" above crest of spillway.

Mar 10, 1958 " 3 3/4" " " " .

CAR USED

CAR MILEAGE

END TRIP

BEGIN TRIP

TRIP MILES

SIGNATURE

TOWN OR CITY ~~Fitchburg~~ DECREE NO. 206 PLAN NO. DAM NO. ~~10-20~~

LOCATION West Dam No Town Reservoir C. C. DOCKET NO.

DESCRIPTION OF DAM

Type	Earth - Mortar Core Wall.
Length	800'
Height	15'
Thickness top	16'
" bottom	55'
Downstream Slope	1 : 1
Upstream "	1½ : 1 riprap
Length of Spillway	None
Size of Gates	"
Location of Gates	
Flashboards used	
Width Flashboards or Gates	
Dam designed by	George Raymond
" constructed by	
Year constructed	

GENERAL REMARKS

Owner: City of Leominster Water Dept.

See Sept. Meeting - 1894
1938 Flood - 4" over Crest.

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream	Leominster Reservoir
" " any other Streams	
Length of Watershed	
Width " "	
Is Watershed Cultivated	
Percent in Forests	
Steepness of Slope	
Kind of Soil	
No. of Acres in Watershed	
" " " " Reservoir	208.
Length of Reservoir	
Width " "	
Max Flow Cu. Ft. per Sec.	
Head or Flashboards-Low Water	
" " " -High "	

GENERAL REMARKS

Inspected: Nov. 14, 1924 - L. O. Marden
Dec. 10, 1928 - " "
Aug. 22, 1930 - " "
Aug. 29, 1931 - " "
Feb. 23, 1933 - " "
June 27, 1935 - " & Guy Clesson
Oct. 10, 1938 - E. C. Corcoran
Measured: Mar. 27, 1939 - J. C. Powers, J. B. Tyteka
Inspected: Oct. 28, 1943 - LOM - G. C. Isaacson

2-Library Bureau 10-52288

Inspected: March 26, 1951. LOM. ✓

TOWN OR CITY ~~Fitchburg~~ Leominster 194 DECREE NO. 206 PLAN NO. - DAM NO. 26-32 ~~10-88~~

LOCATION West dam - No Town Reservoir C. C. DOCKET NO. 40

DESCRIPTION OF DAM

Type	Earth- Mortar Core wall
Length	800'
Height	15'
Thickness top	16"
" bottom	55'
Downstream Slope	1:1
Upstream - "	1½:1 riprap
Length of Spillway	None
Size of Gates	
Location of Gates	
Flashboards used	
Width Flashboards or Gates	
Dam designed by	Geo. Raymond
" constructed by	
Year constructed	

GENERAL REMARKS

Owned by Leominster Reservoir Co.
Inspected Nov. 14, 1924. - L. O. Marden.
See September Meeting 1894.

Inspected: Dec. 10, 1928 - L. O. Marden.
" : Aug. 22, 1930 - " "
" : " 29 - 1934 - " "
" : June 27, 1935 - " and Guy Classon
" : Oct. 10, 1938 - E. C. Corcoran

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream	Leominster Reservoir
" " any other Streams	
Length of Watershed	
Width " "	
Is Watershed Cultivated	
Percent in Forests	
Steepness of Slope	
Kind of Soil	
No. of Acres in Watershed	
" " " " Reservoir	208.
Length of Reservoir	
Width " "	
Max Flow Cu. Ft. per Sec.	
Head or Flashboards-Low Water	
" " " -High "	

GENERAL REMARKS

Owned by City of Leominster
Inspected: Feb. 23. 1933 L. O. Marden.
Measured: Mar. 27. 1939 - J. C. Powers - J. B. Tylula

1938 Flood - 4" over Crest

2-Library Bureau 10-52508

26-12

Inspected: Oct. 10, 1938 - B. P. St. John
" Dec. 19 1942. E. C. Corcoran
" Oct. 28, 1943. L. O. M. - Guy Classon
" Jan. 18, 1949 - L. O. M. - Domon

TOWN OR CITY Leominster DECREE NO. 206 PLAN NO. DAM NO. 26-12

LOCATION Above Goodfellow Dam - "Leominster Reservoir" C. C. DOCKET NO.

DESCRIPTION OF DAM

El. 100

Type Earth dam-Granite masonry spill.
Length 500'
Height 24'
Thickness top 20'.0 =abt =crest
" bottom 80'.0 =spill
Downstream Slope 1½:1
Upstream " 1½:1, riprap
Length of Spillway 50.0 El. crest = 95.0
Size of Gates Waste 2-30" C.I. pipe : El. 76.5
Location of Gates Near ℄ of dam
Flashboards used None
Width Flashboards or Gates -
Dam designed by
" constructed by
Year constructed

GENERAL REMARKS

Owner: City of Leominster. Water Dept.
Recent repairs: None
Leakage: None
Condition: Good
Topography: Wooded-rough
Vol. 22. P. 47 - March 26, 1867 - Oct. 9, 1894 - Sept Mtg.
" 18 " 665 Aug. 1852.
" 28 " 306
Inspected: Nov. 14, 1924 - L.O. Marden

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream Reservoir-Head of Monoosnoc Brook
" " any other Streams
Length of Watershed
Width " "
Is Watershed Cultivated
Percent in Forests
Steepness of Slope
Kind of Soil
No. of Acres in Watershed 1.61 Sq. M
" " " " Reservoir Blueprint - 250.
Length of Reservoir
Width " "
Max Flow Cu. Ft. per Sec.
Head or Flashboards-Low Water
" " " -High "

Dock: #206. M-Sept. 1894. F-Oct. 9, 1894
Traced by: L.C. Farrar, Mar. 2, 1928
Checked by: L.O. Marden, Mar. 4 "
Attested by: William C. Bourg, C.A.C.
George Raymond, C. E., Sept. 1894

GENERAL REMARKS

Inspected: Dec. 10, 1928 L.O. Marden.

" Dec. 7, 1932 - including New Construction west dyke by - L.O. Marden & Guy Classon.
1938 Flood 4" over Crest. (over)
1936 Flood 794.8 1.0 above top of Spillway

Inspected: Oct. 10, 1938 - B. P. St. John

26-12

" Dec. 19 1942. F.C. Corcoran
" Oct. 28, 1943. L.O.M. - Guy Classon
" Jan. 18, 1949 - L.O.M. - Domon

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

now 26-10A

Inspection of Dams, Reservoir Dams, and Reservoirs.

40

Inspected by L.O.Marden Date Dec.10,1928 Dam No. 16-~~26~~

Town Fitchburg Location

Owner Leominster Water Works. Use Water supply

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition none see dam 26-12

EMBANKMENT

El. Top 100. El. Natural Ground water line about 93-94 Width Top 12-13

Width of Bottom Upstream Slope 1:1 Downstream Slope 1:1

Kind of Corewall see plan in office Riprap yes

Material in Embankment earth-loam etc. Foundation

Condition recommand increase downstream slope to 2:1

GATES Location

Size Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure some at south end of embankment running in small ditch along road.

Recent Repairs and Date all brush has been cut.

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet 0-7.3

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

26-12A
40

Inspected by L. O. Marden-Clasgen Date April 29, 1931 Dam No. 15-66

Town Westminster Location

Owner Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition To widen west dyke embankment of No Town Reservoir.

GATES Location

Size Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet B-24

WORCESTER COUNTY ENGINEERING DEPT.
WORCESTER, MASS.

DATE

SUBJECT:

TO

Dec 7, 1932 Lunch, Guy Clossom - inspect new construction at West Dykes (ZC-32)

CAR USED

CAR MILEAGE

END TRIP

BEGIN TRIP

TRIP MILES

SIGNATURE

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

26-12A
43

Inspected by L.O.M. & A.W.F.Brown. Date Feb.23,1933 Dam No. 16-41

Town Fitchburg Location Marshall Dam.

Owner Use

Material and Type

Dam Designed by Phineas Ball.-Worc. Constructed by Geo. Norman. Year 1872

SPILLWAY—Length Feet. Depth Feet

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition

EMBANKMENT—Length overall Feet

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition Good

GATES Location

Size Kind El. Flowline

Condition O.K.

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure None.

Recent Repairs and Date None.

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number of Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

5-26

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

12A
26-32

Inspected by L.O.M. & Classey Date 10-15-93 Dam No. [redacted]

Town Fitchburg now Leominster Location No Town Dyke

Owner Leom W.D. Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition OK - good natural

GATES Location

Size Kind El. Flowline

Condition None

WHEEL Kind Size Rated H. P

Location Ave. Head

Evidence of Leaks in Structure None

Recent Repairs and Date None

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

B-27

TOWN Leominster

DAM NO. 12A-32

LOCATION Embankment to No Town Res—

STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT

WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Leominster W. D. PLACE USE

INSPECTED BY L H Spafford DATE 10/22/54

TYPE OF DAM CONDITION

SPILLWAY

FLASHBOARDS IN PLACE RECENT REPAIRS

CONDITION

REPAIRS NEEDED

EMBANKMENT

RECENT REPAIRS Dike in good condition

CONDITION

REPAIRS NEEDED

GATES None

RECENT REPAIRS

CONDITION

REPAIRS NEEDED

LEAKS

HOW SERIOUS

DATE

COUNTY ENGINEER

TOWN Leominster DAM NO. 26-12A

LOCATION Along the easterly side of Palmer Rd. STREAM Monoosnoc Brook

"No town Reservoir"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by City of Leominster Place Water Dept. Use Water supply

Inspected by WOL Date Oct. 5 1954

Type of Dam Earth dike Condition Good

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition No spillway in this location

Repairs Needed _____

EMBANKMENT

Recent Repairs This earth embankment is 16' wide on top - 2 to 1 slopes -

Condition It has riprap on the upstream slope - and is 6' to 15' high.

Repairs Needed It is covered with brush

GATES

Recent Repairs _____

Condition No gate.

Repairs Needed _____

LEAKS

How Serious _____

DATE: _____ County Engineer

"From 1978 Coffin & Richardson Report"

DISCUSSION AND RECOMMENDATIONS

General

Appendix A lists in detail the conditions found at each facility during the inspections. The following section discusses the general conditions by type of facility and the reasons for repair or replacement. The cost estimates are calculated based upon repairing all the similar facilities at one time under a contract. An example would be a contract for repair of all the gate houses, including roof repair, pointing and replacement of bricks, screen replacement, etc., and the contractor would be expected to perform the necessary work at each site. Tree clearing of the Reservoirs would be another example and the repair of all spillways would be a third example of a separate contract.

Reservoirs and Dams

Most of the dams are of the earth fill type, with riprap on the upstream face. Various size trees and light to heavy brush were found growing on the downstream slopes of the structures when the inspection was made. These trees should be cut down and the stumps left in place. If they were to be knocked down by a storm, the tree would open a large hole in the dam, possibly at a critical spot in the structure and could cause a failure of the dam if water began to seep through.

The brush should be cleared off the dam for the same reason, i.e. small trees grow to be problems, and the brush hides possible leaks and weep points. The broad leaf brush

and trees around the edges of the reservoirs should be removed and the area replanted to pine. This will reduce the number of leaves that blow into the water in the Fall and decompose, adding color to the water.

Controlled grass growth should be encouraged on the downstream face of the earth dams to protect against erosion.

The rip-rap on the face of the dams appeared to be in good repair at the time of inspection. However they should be re-examined when the reservoirs are drawn down. No stones should be out of place because the earth structure is susceptible to erosion from wave action.

The spillways should be clear of brush and debris and the walls in good condition. In a flood, brush and debris could obstruct the flow and the water could back up behind the spillway and the dam could be over-topped and fail. The high velocity of spring and flood flows through weak or damaged spillway channels can only cause more damage to those channels and eventual erosion of the ground the channel walls were intended to protect.

It is recommended that a program be started to remove the large trees and brush at the dams, around the reservoirs, and along the spillway channels, in conjunction with the City's Forester. The Forester should be responsible for the tree removals and replanting around the reservoirs and in the watersheds, and the Water Department should maintain the dam areas. Once the large trees are removed, the growth of small brush and grass should be controlled so that the dams can be easily inspected.

Massachusetts has state regulations which govern the use of herbicides in general and their use around reservoirs in water supply drainage areas in particular. The City or a contractor must apply for a permit from the Pesticide Board in Boston to use chemicals. A copy of the Pesticide Board Rules and Regulations is included in this report as Appendix D.

The Department of the Army, Office of the Chief of Engineers, has published "Recommended Guidelines for Safety Inspection of Dams", November 1976, and has started a program of the inspection of dams in New England. The program field work is starting in 1978 and will continue for four years. Criteria for evaluating spillway capacity are included based on size and hazard potential. The criteria for spillway capacity are not significantly different from those generally used for the design of new dams, but do require considerably larger spillway capacity than is available in many old earth fill dams in New England and other parts of the country.

At present, the improvements necessary to bring the old dams up to present-day standards are the responsibility of the owner. However, it is expected that the survey will show that the cost of making these improvements will be large; and to get the work accomplished in a reasonable period of time, a program of Federal assistance will be required.

In Table 4, the size, hazard potential, and the range of the flood inflow to the reservoirs in the Leominster water supply system for which the spillway should be capable of handling under the guidelines is shown. A 100-year flood is one that

"From 1978 Coffin & Richardson Report"

CITY OF LEOMINSTER
DEPARTMENT OF PUBLIC WORKS

TABLE 4

WATER SUPPLY RESERVOIR
SPILLWAY DESIGN FLOOD CRITERIA

Dam	Size	Hazard Potential	Spillway Design Flood (SDF)
Haynes	Small	Significant	100 yr. to ½ MPF
Morse	Small	Significant	100 yr. to ½ MPF
Distributing	Small	Significant	100 yr. to ½ MPF
No-Town	Intermediate	High	MPF
Good Fellow's	Small	High	½ MPF to MPF
Simond's	Small	High	½ MPF to MPF
Fall Brook	Intermediate	Significant	½ MPF to MPF

occurs with a frequency of one in 100 years. A flood of half the maximum probable flood (MPF) occurs with a frequency of one in about 700 years. The maximum probable flood occurs with a frequency of once in more than 2,000 years. Floods of these magnitudes are rare; however, floods with recurrence intervals of the order of once in 300 years have occurred in New England and water supply reservoirs of similar vintage as those in Leominster have failed. Floods of this magnitude have not occurred in the Leominster area; however, it would be prudent to have a plan available for implementation when major storms occur.

The plan should include:

1. Provisions for a person or persons to visit the sites frequently to measure the increase in water surface elevation and observe any erosion that is harmful to the safety of the dams.
2. Instruction as to opening blow-off valves and removal of flashboards.
3. Arrangements for warning the inhabitants downstream of the dam.
4. Provisions for making sandbags, men and equipment available at the dams if overtopping of the dam is threatened.

During the inspection, it was found that many of the spillway sidewalls, channel beds, and crests have deteriorated. Further erosion of the channel sidewalls will eventually cause collapse of the sidewalls. This would most likely occur during high flows after a heavy rainfall, but not necessarily one that

would cause a flood. The collapsed section would restrict the channel area and expose the readily erodible material behind it. The damming effect of the debris could result in the overtopping of the channel wall upstream or of the dam embankment. Erosion behind the collapsed section could result in the diversion of water from the channel to areas near the downstream toe of the dam.

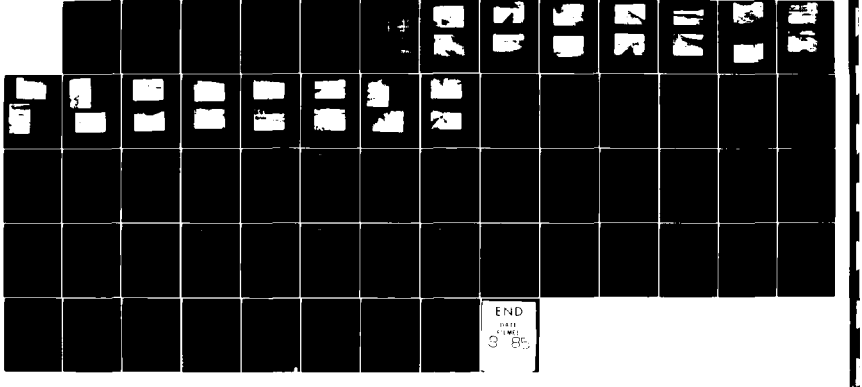
Obstruction to flow in the channel bed or upstream of the spillway crest, such as brush and accumulated debris, tend to trap any further debris which may float to the spillway area during a period of heavy runoff. The further compounded damming effect could result in overtopping of the dam or channel walls.

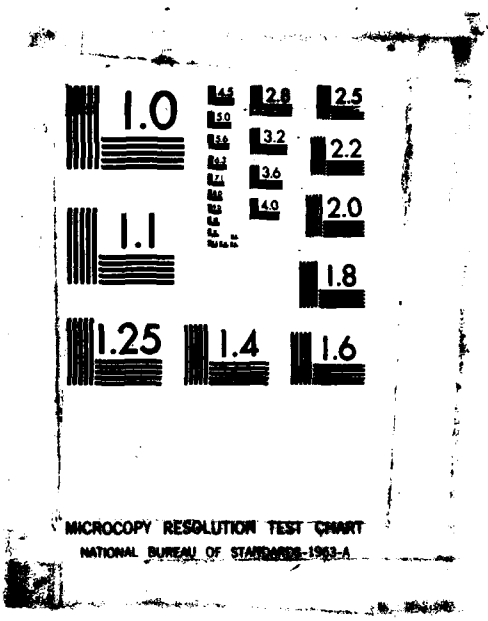
Since there is no surplus capacity in the various spillways, they should be repaired and maintained in good condition. A program for routine inspection and removal of debris should also be implemented.

The gate houses, or intake structures, screens, blowoffs, and gate valves on all dams need repair. The gate house structures should be repaired to good condition and strong anti-vandal material used. Protection of valves and screens from unauthorized use or damage is an important consideration. The operability of valves at the dam at any time is a necessary criteria. Existing valves should be repaired or replaced and when they are not in the gate house, marked by signs.

AD-A155 680 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS NOTOWN RESERVOIR DAM A..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV MAR 80 2/2

UNCLASSIFIED F/G 13/13 NL




1.0
1.1
1.25
1.4
1.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

"From 1978 Coffin & Richardson Report"

CITY OF LEOMINSTER
DEPARTMENT OF PUBLIC WORKS

TABLE 5

DAM AND RESERVOIR REPAIRS
COST ESTIMATE

	Reservoir	Clearing & Chipping Of Trees (1)	Repairing of Spillways	Repairing Gate Houses	Total by Reservoir
a.	Haynes	$10,000	$14,000	$ 3,500	$ 27,500
b.	Morse	5,000	7,500	12,000	24,500
c.	Distributing	2,500	2,500	6,000	11,000
d.	Fallbrook(2)	10,000	4,000	13,000	27,000
e.	No-Town	5,000	25,000	-	30,000
f.	Goodfellow's	1,500	16,000	45,000	62,500
g.	Simond's	500	8,500	9,000	18,000
Totals by Project		$34,500	$77,500	$88,500	$200,500

(1) At dam areas only.

(2) Includes work at the diversion dam.

The spillway channel should be cleared of brush and debris and the entrance granite blocks re-positioned and secured by grouting. The blowoff headwall and channel should be cleared of brush and trees and the poison ivy in the area of the dam eliminated.

The Fall Brook chlorination and meter building was renovated in 1977 in a similar manner as the Distributing building. The existing building was divided into two rooms to house the chlorinators and the chlorine gas storage room and an addition was constructed to house a propane gas standby engine generator. The existing heating system was not changed. Comparison calculations were made and indicate that the heating system is as efficient as the new system installed at Distributing and, in fact, the oil heating system now has one advantage over the LP gas system because of a 20.5 cents per gallon surcharge being paid for the LP gas. When that surcharge is dropped, the systems will be equivalent in cost.

The basement of the chlorination station is in need of cleaning and painting.

No-Town Reservoir

The spillway channel concrete sidewalls and bed, and the discharge channel sidewalls need extensive repair. The spillway channel sidewalls should be removed and new sidewalls constructed where conditions are the worst. It is only a matter of time before sections will collapse into the channel and block flows. Undercut areas of the sidewalls along the entire length should be grouted to stop the erosion. The extensive brush growth in the channel and along the sides should be removed to prevent damage to the concrete structure.

The discharge channel stone sidewalls need resurfacing with concrete to prevent further undercutting and collapse of the sidewalls. The discharge pipe headwall should be rebuilt.

Goodfellow's Reservoir

The gatehouse should be rebuilt because the existing structure has deteriorated beyond economic repair. The aeration system gate valve should be rebuilt or replaced and the system flushed out and cleaned for operation. It should be determined if a blowoff exists.

The spillway channel bed and sidewalls need extensive repair. The stone bed should be rebuilt by repositioning the stones and grouting them in place as originally existed. The channel sidewalls should be rebuilt since they are undercut and are starting to collapse.

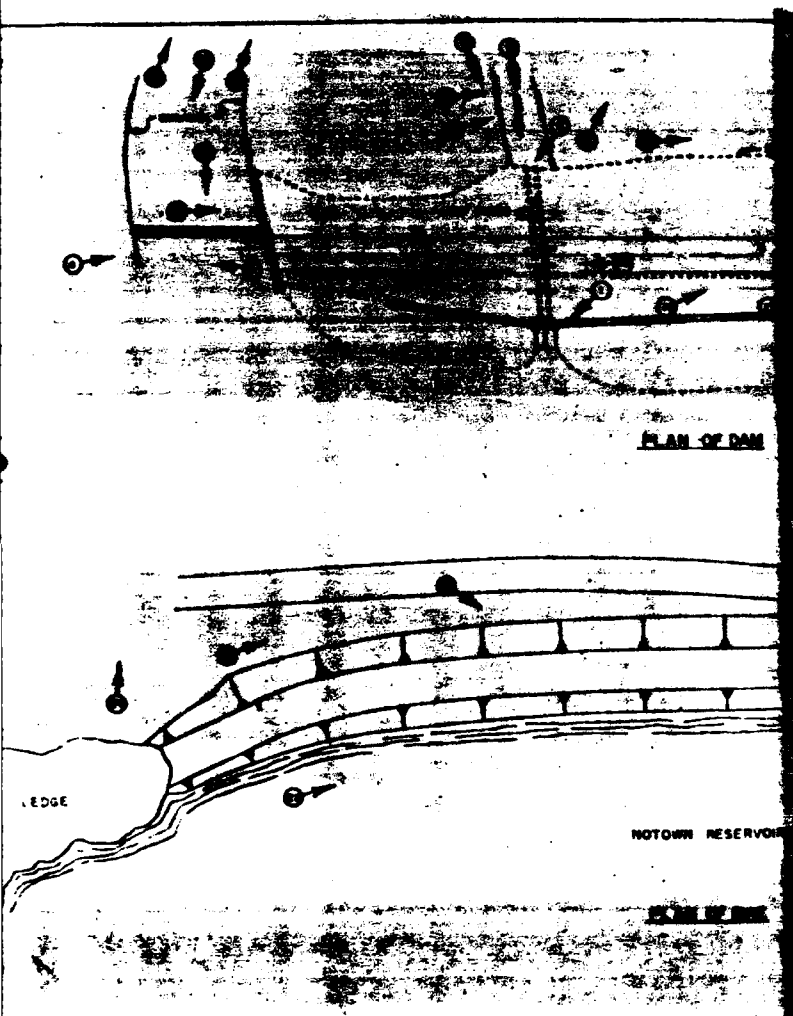
The excessive growth of trees and heavy brush on the downstream face of the dam on both sides of the spillway and in the spillway channel should be removed before severe damage to the integrity of the dam occurs. All deciduous trees lining the reservoir and along the brook to Simond's Reservoir should be removed and replaced with pines.

Simond's Reservoir

The gatehouse concrete substructure should be grouted where spalling and cracks have occurred. The door and frame and the iron rail along the top of the dam need repairs, cleaning and painting. The flashboards, plastic liner and sandbags need minor repairs.

APPENDIX C

PHOTOGRAPHS



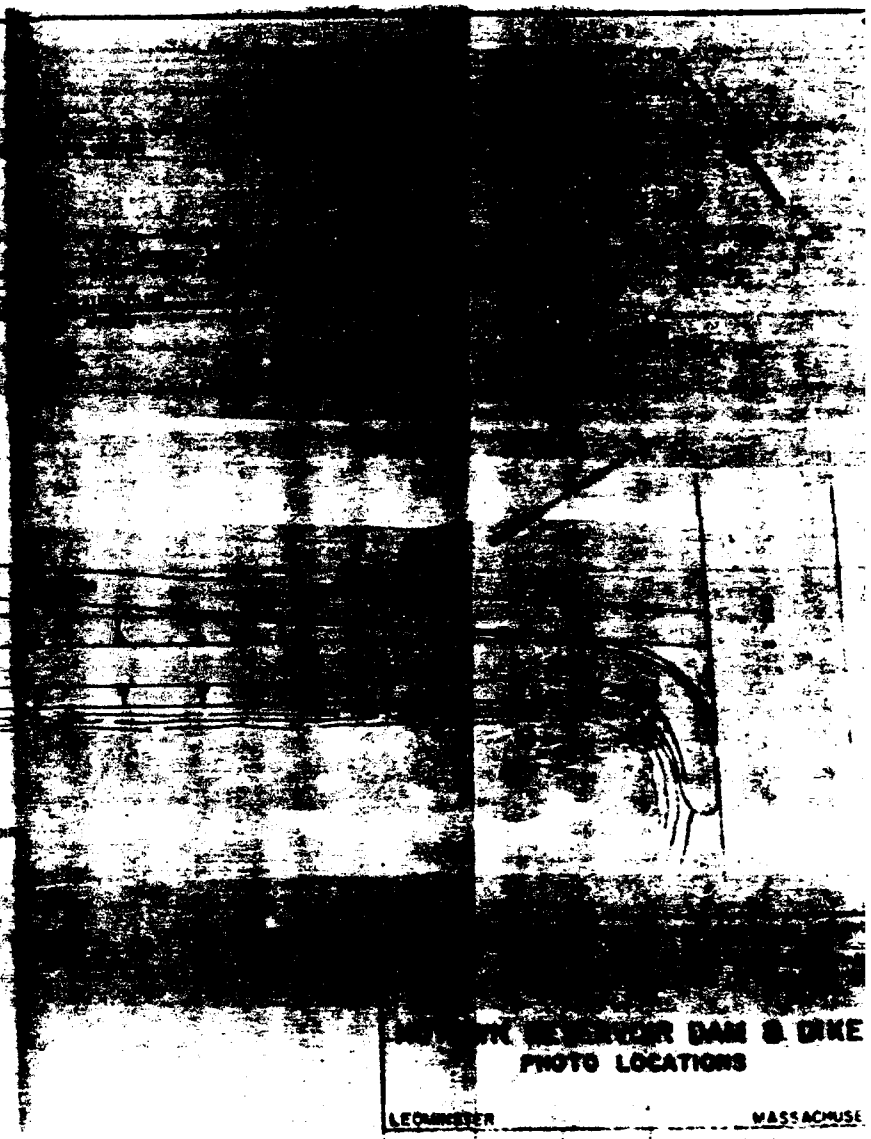


PHOTO LOCATIONS

LEOMINSTER MASSACHUSE

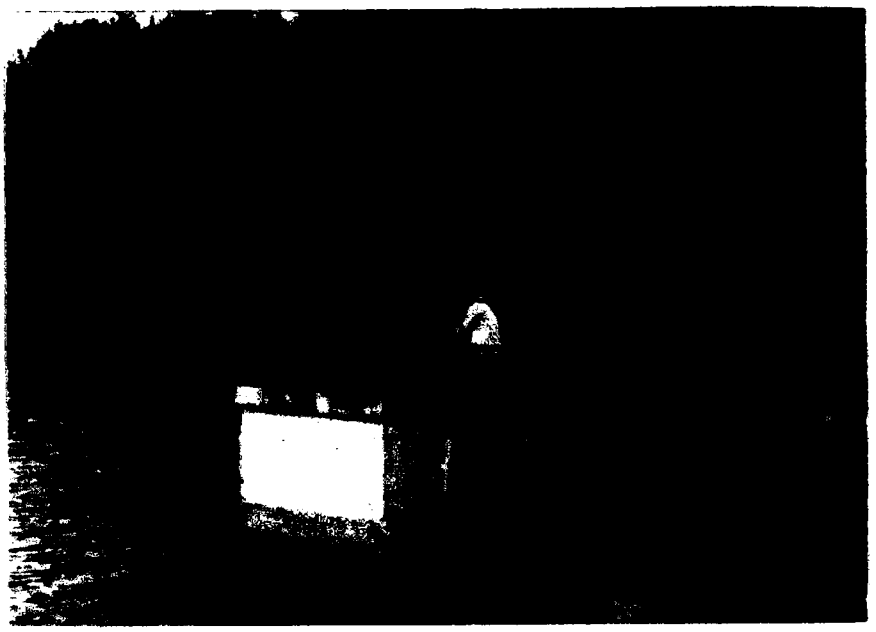


PHOTO NO. 1 - Intake structure for the two gated 24 inch outlet pipe.

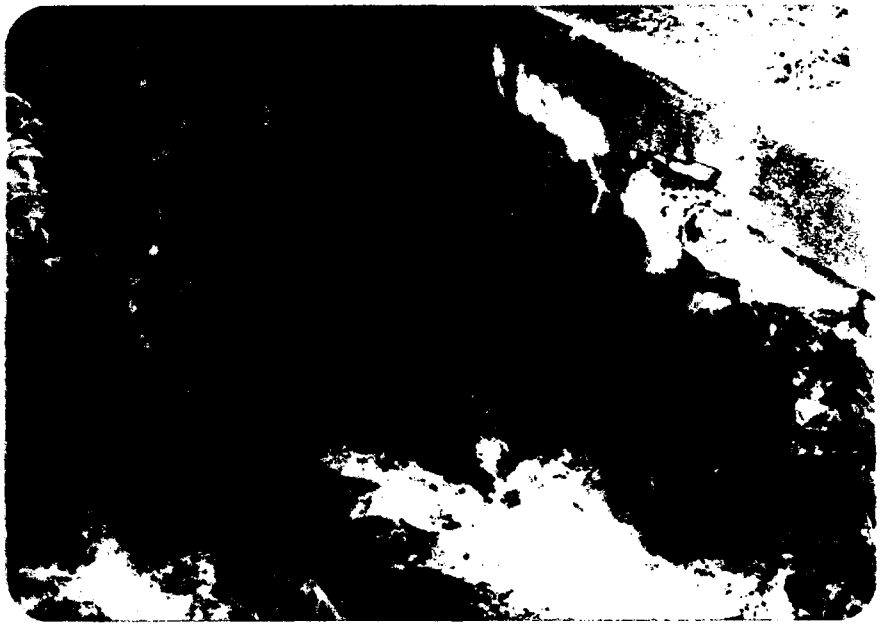


PHOTO NO. 2 - This photo shows the two 24 inch cast iron water supply pipes. These pipes have manually controlled gates at the intake structure. Note the orange colored stain and seepage to the right of the pipe at center of the photo.

PHOTO NO. 3 - This photo shows the water supply outlet channel, looking toward the Dam. The channel has concrete capped stone masonry walls with a gravel bottom.

PHOTO NO. 4 - This photo was taken from the left abutment area looking across the spillway (foreground) along the top of Dam. Note the top of the concrete core wall, concrete masonry intake structure; and the elevation of the intake structure service bridge.

PHOTO NO. 5 - This photo shows the spillway crest as seen from the outlet channel.Eight inch high flashboards are normally used. Note one eight foot long section is missing. The spillway was originally constructed of stone masonry. The present concrete cap was a later modification.

PHOTO NO. 6 - Spillway weir from crest of Dam to left of spillway.

PHOTO NO. 7 - This photo shows the upstream face and top of Dam from the right abutment. Note that the riprap slope protection extends to the crest of Dam where it meets the top of the upper concrete core wall.

PHOTO NO. 8 - Outlet pipe from 90 feet downstream of outlet pipes.

PHOTO NO. 9 - This photo taken from the right abutment shows the reservoir area. The main body of the reservoir is to the South and Northwest of this location.

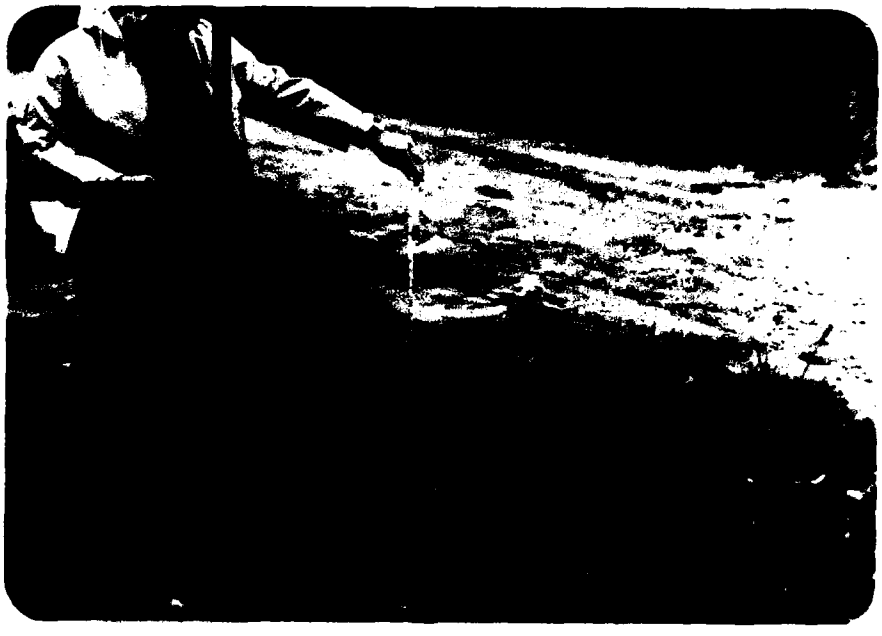


PHOTO NO. 10 - This photo shows that about 2 to 3 inches of displacement has occurred between the intake structure service bridge abutment and the top of core wall. It appears that the walkway has settled.

PHOTO NO. 11 - This photo shows the outlet channel just downstream of the spillway. The entire channel is about 300 feet long. The channel walls and bottom were constructed of stone masonry. The tops of the walls were later capped with concrete. The channel bottom is sloped and has stone masonry steps about 1 foot high at irregular intervals to develop a 20± foot change in elevation. The downstream brook can be seen at the center of the photo. Here, the spillway channel meets with the water supply discharge channel to form Monoosoc Brook which flows Eastward to Leominster. The water treatment plant is about 1 mile downstream.

PHOTO NO. 12 - Swampy area downstream of Dam from right abutment.

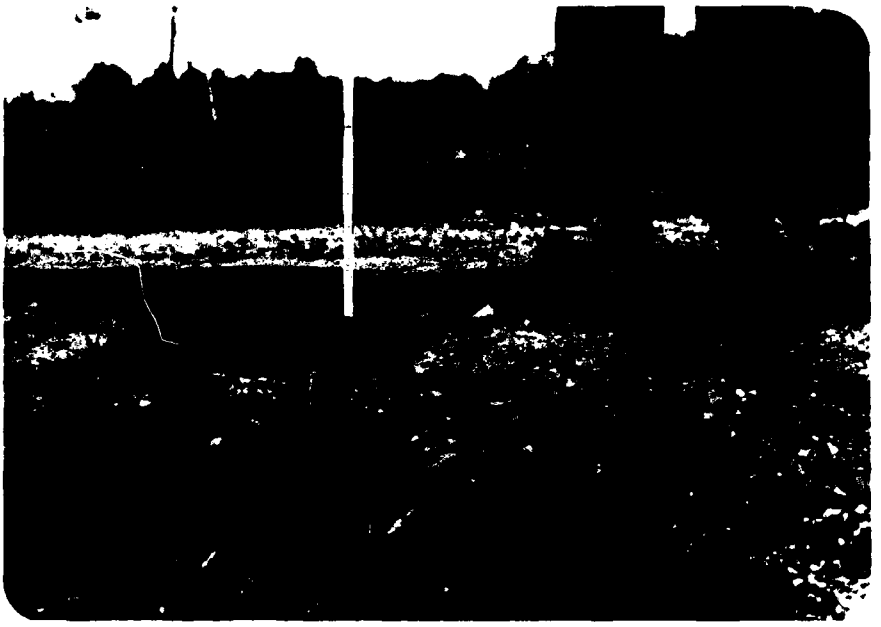


PHOTO NO. 13 - Displacement of riprap on upstream slope about 95 feet left of right abutment.

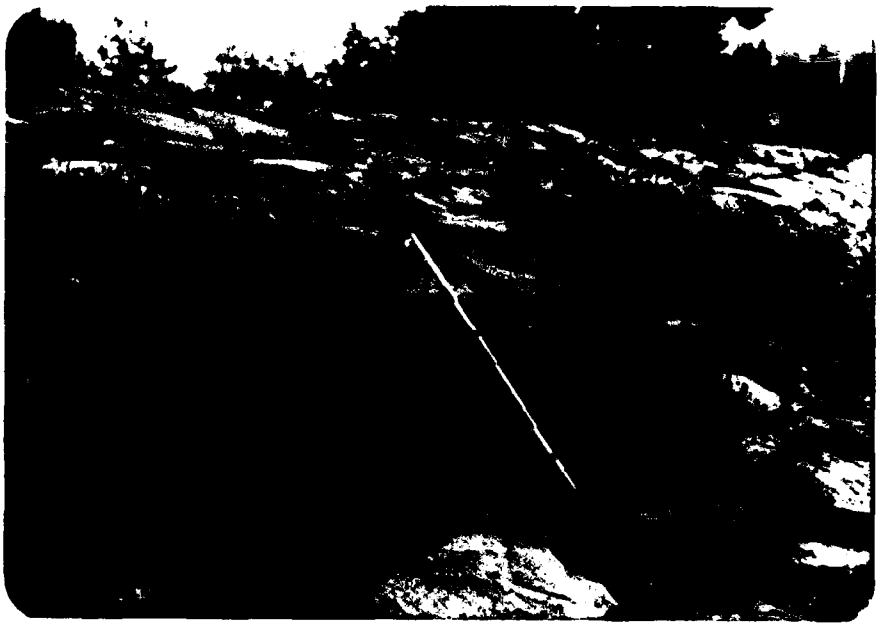


PHOTO NO. 14 - Brush stumps on upstream slope.

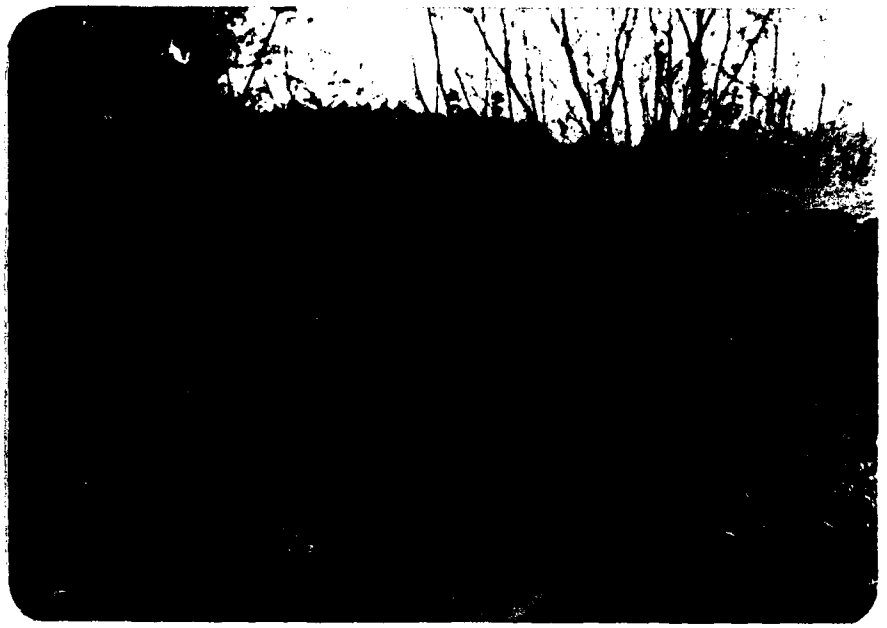


PHOTO NO. 15 - Concrete section of right training wall of spillway from spillway weir.

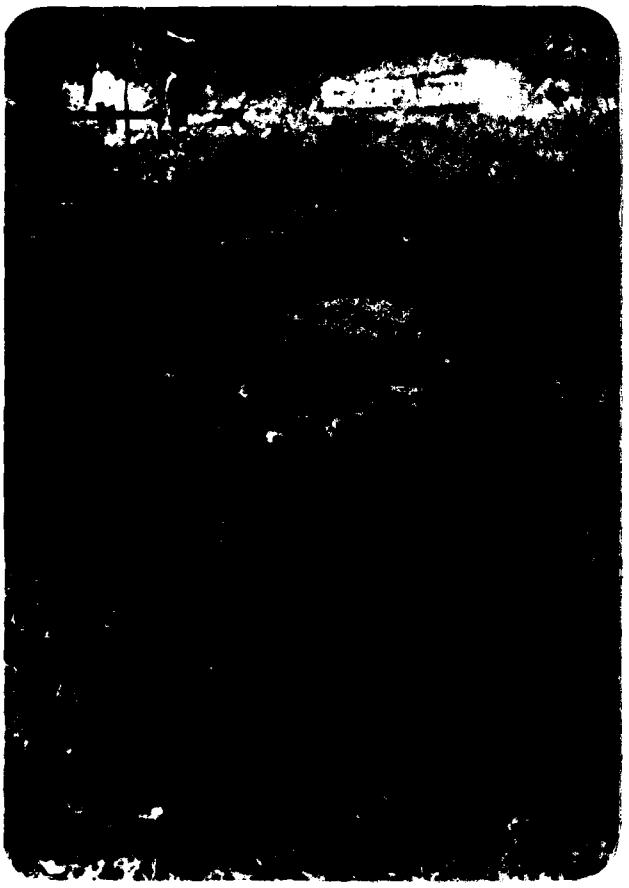


PHOTO NO. 16 - Spillway channel looking upstream from about 150 feet downstream of spillway weir. Note stepped construction.

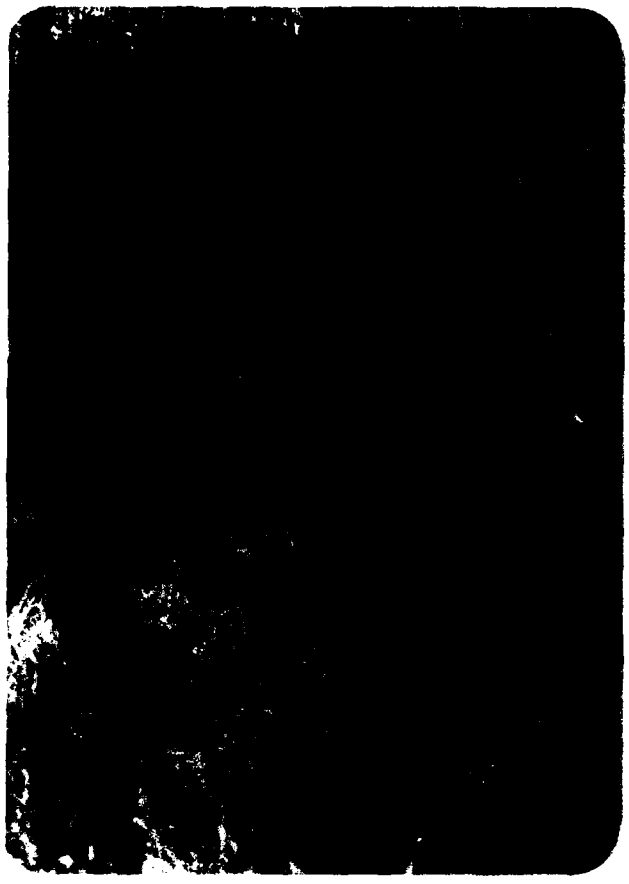


PHOTO NO. 17 - Right wall of downstream channel from spillway at about 50 feet upstream of confluence with outlet downstream channel.

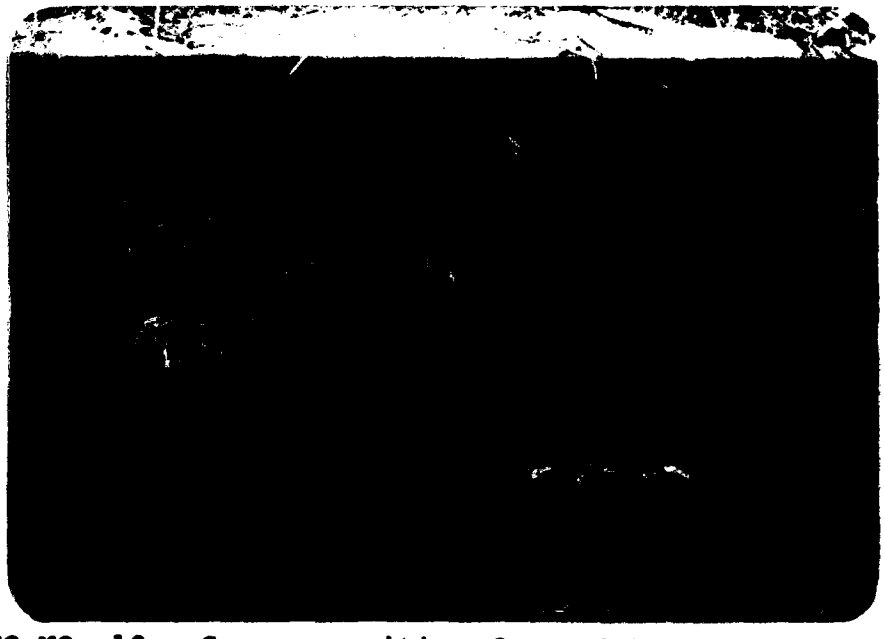


PHOTO NO. 18 - Seepage exiting from right wall of outlet channel about 145 feet downstream of outlet pipes.

PHOTO NO. 19 - Seepage exiting from right wall of outlet channel about 100 feet downstream of outlet pipes.

PHOTO NO. 20 - Downstream toe of Dam to right of outlet pipes.

PHOTO NO. 21 - Area downstream of Dam from left wall of outlet channel.

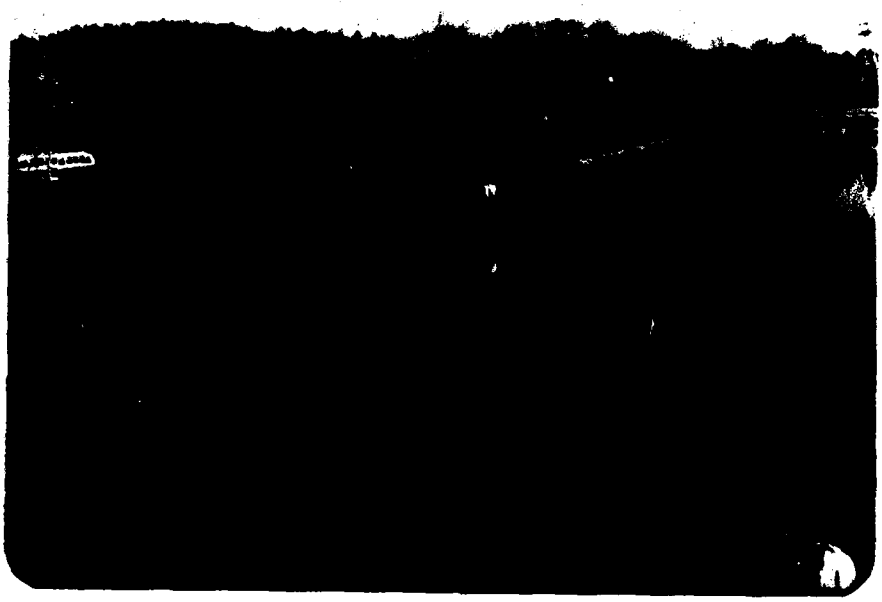


PHOTO NO. 22 - This view shows the upstream face and top of Dike looking North towards Route 2. Note the junk yard near the toe of the embankment, in the upper left corner.

PHOTO NO. 23 - This photo shows the top of Dike and Palmer Road which is at the toe of the Dike. The road parallels the Dike for about 500 feet. The Dike's maximum height of 13 feet occurs at this location.

PHOTO NO. 24 - This view shows the downstream area near the left abutment and center of the Dike. This area is within the Dam failure impact area. Flood stage could be 5 feet deep or more.

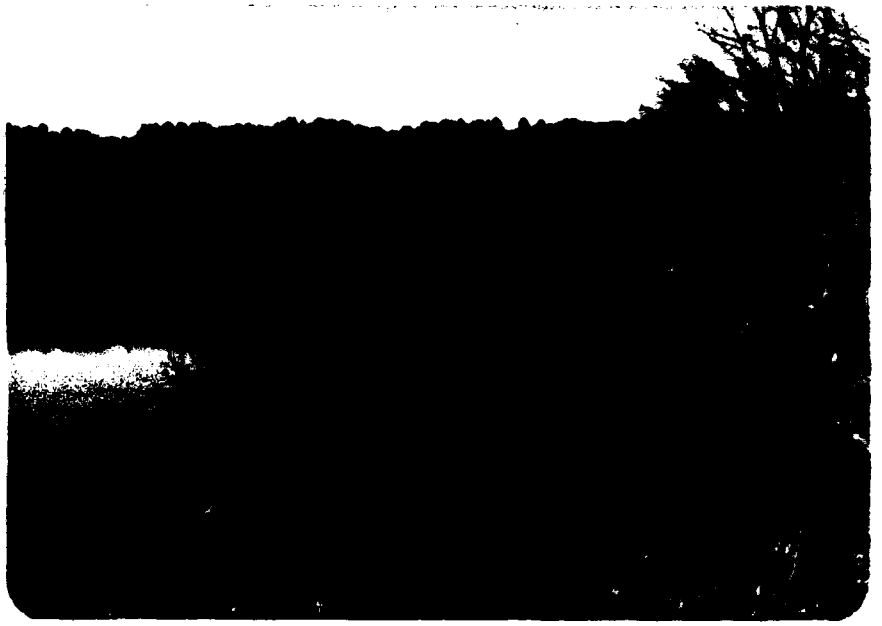


PHOTO NO. 25 - This photo shows the upstream face and top of Dike as seen from the right abutment near Route 2.

PHOTO NO. 26 - Right abutment from upstream slope.

PHOTO NO. 27 - Swampy area downstream of Dike and roadway at toe of Dike.

PHOTO NO. 28 - Standing water at downstream toe of Dike about 100 feet right of left abutment.

PHOTO NO. 29 - Path on downstream slope of Dike.

PHOTO NO. 30 - Parking area cut into downstream slope of Dike about 150 feet left of right abutment.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

JOB NO. 79.206.1
DATE 10-23-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. D2
JOB Dams
SUBJECT No Town Res
CLIENT COE

Rev 3-13-80 MA
ch'd 3-14-80 FDD

Main Dam

Built prior to 1894 (probably 1870's)

Hydraulic Height ≃ 21. ft. ±.
Storage Capacity ≃ 3900. a-ft ±.
Size Class ≃ Intermediate (3900 a-f)

Hazard Potential = High.

Test Flood = PMF.

Drainage Area = 2925. acres (4.57 s.m.)
(overland / brook flow).

Test Flood inflow = $1 \times 4.57^{sm} \times 1875^{cfsm} = 8600 \pm cfs$ PMF INFLOW.
(rolling-terrain)

Test Flood Outflow = 5070 cfs Dam, dike and a section of Rte 2 are over-topped by 0.9± ft to elev 741.5±.

1/2 PMF inflow = 4300 cfs : outflow ≡ 1720 cfs
spillway surcharged to elev. 740.4

Dike ... Hazard Potential = High
no spillway at dike

Spillway passes 37% of PMF test fld outflow

Spillway passes 100% of 1/2 PMF outflow

PMF Tailwater @ Main Dam ≃ 725

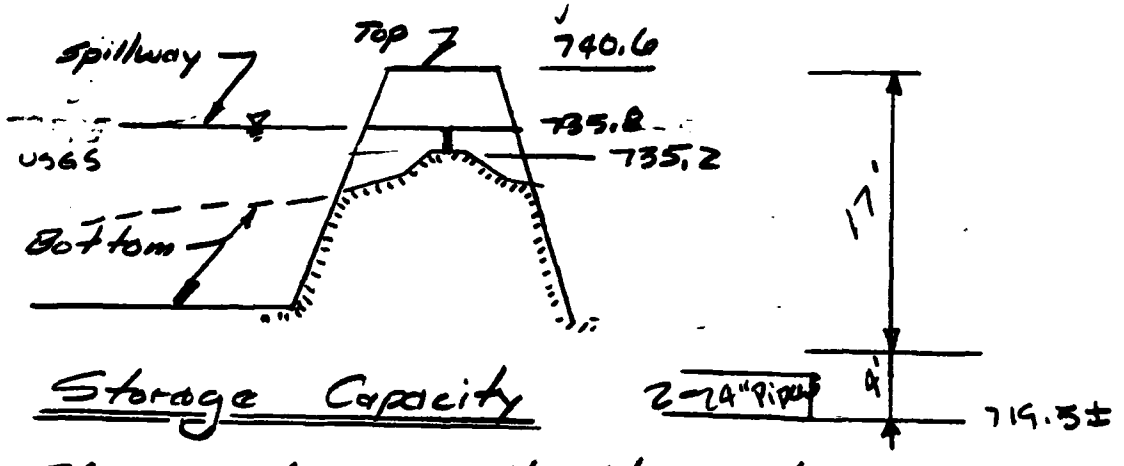
JOB NO. 79.206.1
DATE 10-23-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. D 20
JOB Dams
SUBJECT No Town Res
CLIENT COE

Rev 3-13-80 MA
ch'd 3-14-80 FDD

Main Dam

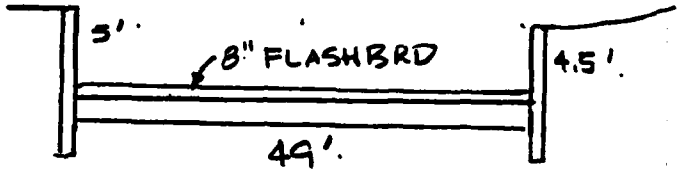


Storage Capacity

Elev.	Area-a	Height-F	A-F	Accum A-F
750.	520			
740.6	315	273.	5.45.	1488.	3984.
735.15	230	209.	5.15.	1076.	2496.
730.0	187	142.	10.	1420.	1420.
720.0	97			

Spillway Capacity

$Q = CLH^{3/2}$



D	C	L	$H^{3/2}$	Q CFS
1	3.6	49	1	176.
2	3.53	"	2.82.	489.
3	3.44	"	5.2.	876.
4	3.48	"	8.	1364.
5	3.57	"	11.18.	1956.

Dam Overflow					Rte 2 (50' section) + Dike Overflow					Total Overflow
1	2.64.	600.	1	1584.	1'	2.64	800'	1	2112	3696.
0.5	"	"	.35	560.	0.5	"	"	.35	740	1300.
1.5	"	"	1.84	2900.	1.5	"	"	1.84	3900	6800.

JOB NO. 79.206
DATE 11-16-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

Rev 3-13-80 MA
Ch'd 3-14-80 FDD

JOB DAMS SHEET NO D3
SUBJECT NOTOWN
CLIENT COE

TEST FLOOD ANALYSIS - MAIN DAM

PMF Inflow = 8600 cfs = Q_{P_1}

El_1 = 742.1 $Stor_1$ = 4500 - 2500 = 2000 a-f = 8.2"

$Q_{P_2} = 8600\left(1 - \frac{8.2}{19}\right) = 4886$ cfs $El_2 = 741.5$

$Stor_2$ = 4300 - 2500 = 1800 = 7.4"

$Storage = \frac{7.4 + 8.2}{2} = 7.8"$

$Q_{P_3} = 8600\left(1 - \frac{7.8}{19}\right) = 5070^{\pm}$ cfs

$El_3 = 741.5$

Dam & Dike + 50'± section Rte 2 are over topped by 0.9± ft.

Spillway at top of dam pass - 37%± of outflow (with 8" flashboard in place)

DAM FAILURE

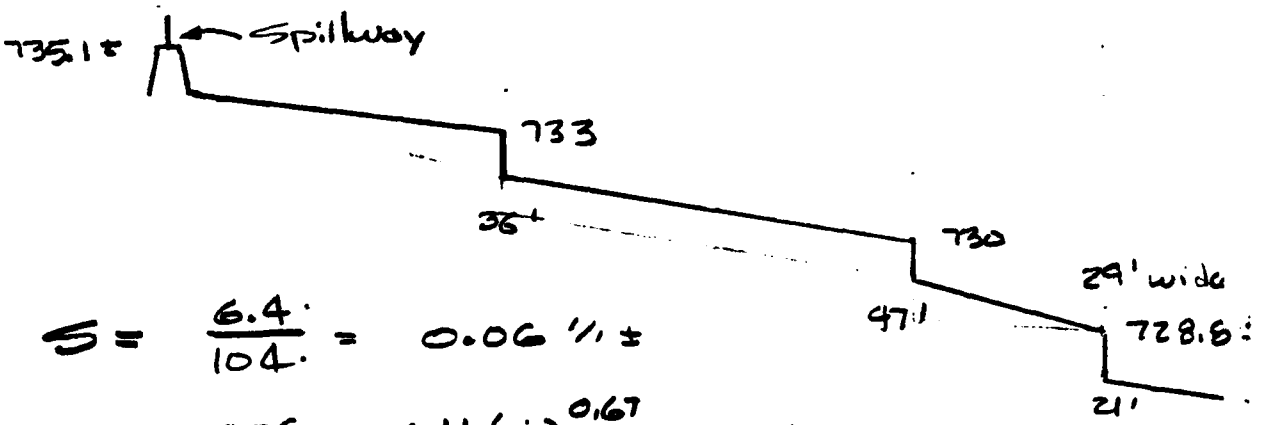
$$Q_F = 8/27\ (0.4 \times 275^{\pm})\sqrt{32.2}\ (21.)^{1.5}$$

Q_F = 17,835. cfs

Base flow from spillway ≈ 1850 cfs

Outlet Channel Capacity

= 740.6 Top of Dam



$S = \frac{6.4'}{104'} = 0.06$ ft/ft ±

$V = \frac{1.486}{0.04} \times \left(\frac{116'}{37'}\right)^{0.67} \times (.06)^{1/2} = 19.6'$ fps

$Q = VA = 19.6(116) = 2270'$ ± cfs

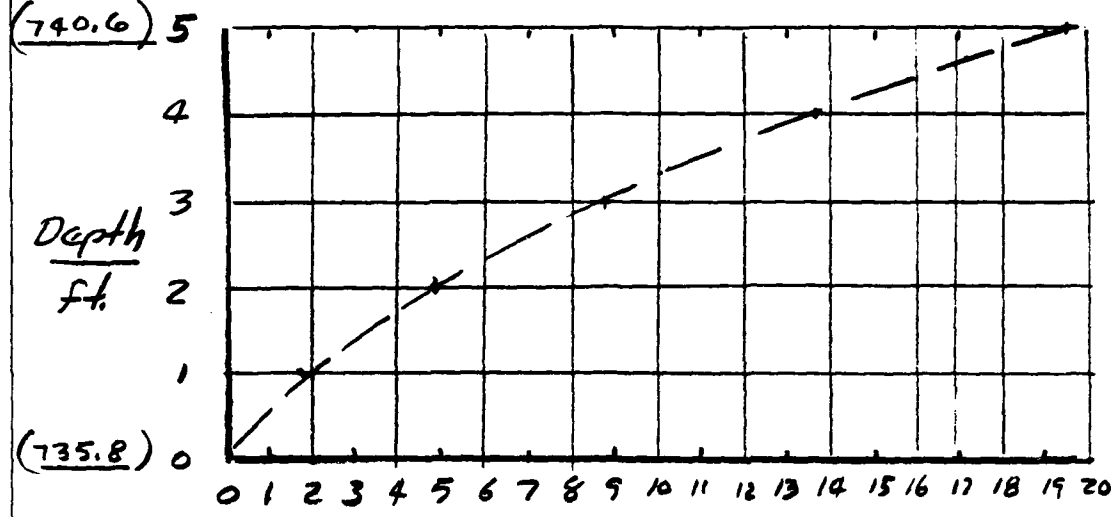
Test flood discharge is about ~3500 cfs at main dam. Channel is not adequate.

JOB NO. 79.206.1
DATE 3-13-80
BY MA
CH'D BY FDD

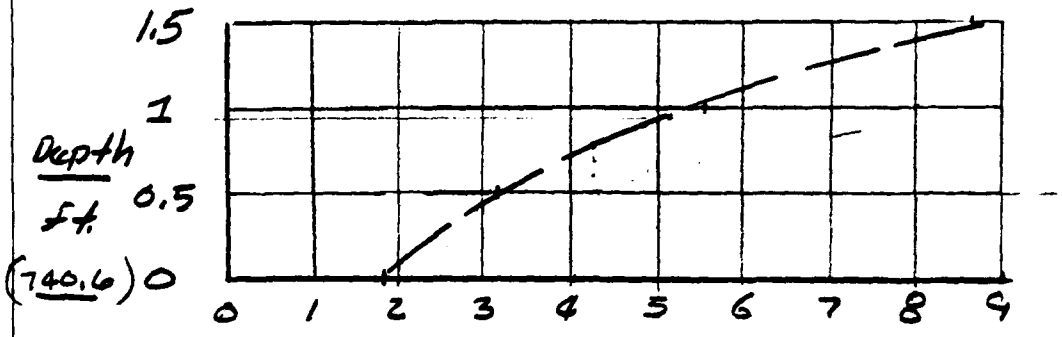
HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D4
JOB Dams
SUBJECT Natoma Res
CLIENT COE

Stage Discharge - Main Dam



Spillway Discharge x 100 cfs



Dike, Dam, Rte 2 Overflow

Discharge x 1000 cfs

JOB NO. 79.206
DATE 11-16-79
BY MA
CH'D BY FDD

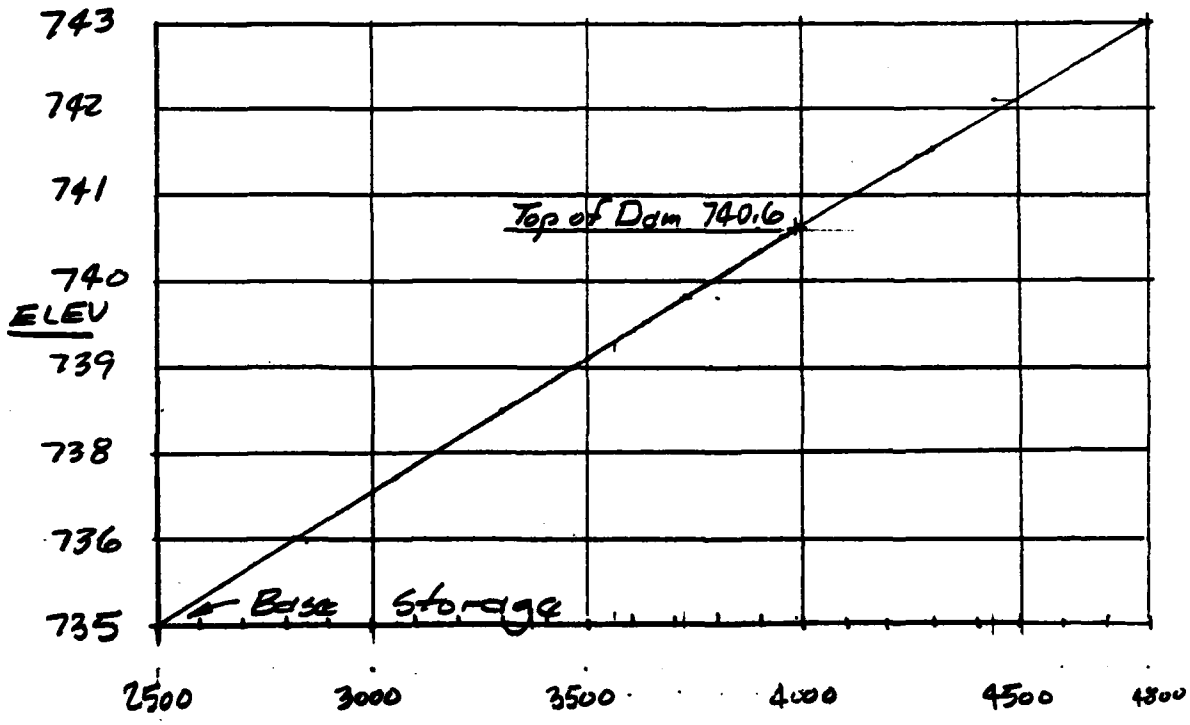
HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D5
JOB DAMS
SUBJECT NOTTAWA
CLIENT COE

Rev 3-13-80 MA
Chd 3-14-80 FDD

Main Dam - Dike

STAGE STORAGE



1/2 PMF Discharge from Spillway

$Qp_1 = 4300$ $El_1 = 741.4$ (0.8')
$Stor_1 = 4275 - 2500 = 1775$ a-f on 7.3"

$Qp_2 = 4300\left(1 - \frac{7.3}{9.5}\right) = 1000.\pm$ cfs $El_2 = 739.1$ (3.3')
$Stor_2 = 3500 - 2500 = 1000$ a-f on 4.1"
$Storage = \frac{4.1 + 7.3}{2} = 5.7"$

$Qp_3 = 4300\left(1 - \frac{5.7}{9.5}\right) = 1720$ cfs $El_3 = 740.4$

Dam & Dike are not overtopped!

JOB NO. 79.206
DATE 11-16-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D6
JOB DAMS
SUBJECT NOTOWN
CLIENT COE

Sta 10+00 to 110+00 ARE FOR MAIN DAM

STA 10+00

$S = (719.5 - 715) \div 1000 = 0.0045$ ft/ft

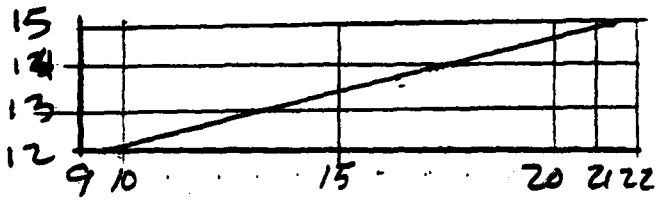
$V = \frac{1.486}{n} R^{2/3} (0.0045)^{1/2} = R^{2/3} (\quad)$

n = .035 2.85
.06 1.66

S_f = 3900 c.f

Brook

D	WP	A	$R^{2/3}$	2.85	V	Q	
3	26	60	1.75	"	5	300	cont carry Q_s
				1.66	2.9	174	
5	300	360	1.13	"	1.88	675	
10	500	1200	1.79	"	2.98	3582	
20	750	7400	4.6	"	7.7	56942	
15	675	3950	3.27	"	5.4	21,419	
12	550	2250	2.57	"	4.27	9,599	



$El_1 = 14'$

Q_{P_1} = 16,710 cfs + cfs base flow
6' fld.

$Q_{P_2} = 17835\left(1 - \frac{76}{3900}\right) = 17{,}487$ cfs (17,721)

$El_2 = 13.9$ $S_{t_2} = 71$ ave = 74±

$Q_{P_3} = 17835\left(1 - \frac{74}{3900}\right) = 17496$ cfs $d_3 = 14'$.

Elev = 734 ±.

JOB NO. 79.206
DATE 11-16-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

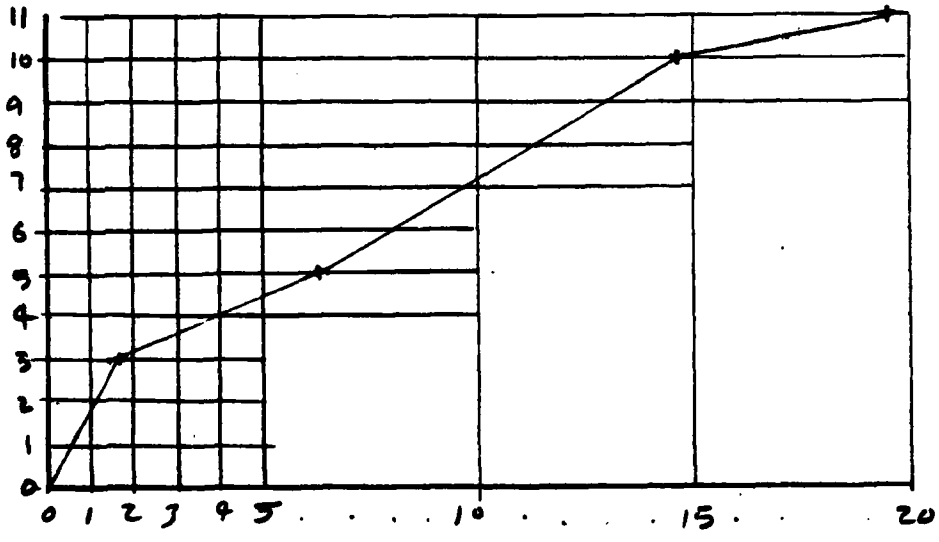
SHEET NO. D7
JOB DAMS
SUBJECT NOTCH
CLIENT COE

STA 20+00

$Q_{P_1} = 17,496.$ (Base flow = 1125 cfs)

$V = \frac{1.486}{.06} R^{2/3}(0.0045)^{1/2} = 1.66 \cdot R^{2/3}$

D	WP	A	$R^{2/3}$	1.66	V	Q	Elev
5'	500	1675	2.25.	"	3.73.	6250.	724.
3'	450	735	1.39.	"	2.3.	1695.	722 ✓.
10'	600	3000	2.94.	"	4.88.	14640.	729.
11'	625	3625	3.25.	"	5.39.	19540.	736.



$Q_{P_1} = 17,496.$ $d_1 = 10.5'$. $S_1 = \frac{3312}{1} \times \frac{1000}{43560} = 76$ c.f.s.

$Q_{P_2} = 17496\left(1 - \frac{76}{3900}\right) = 17155.$ $d_2 = 10.3.$ $S_2 = 73.$

$Q_{P_3} = 17496\left(1 - \frac{74.5}{3900}\right) = 17,162.$

ELEV. = 729.5 ±

JOB NO. 79.206
DATE 12-3-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

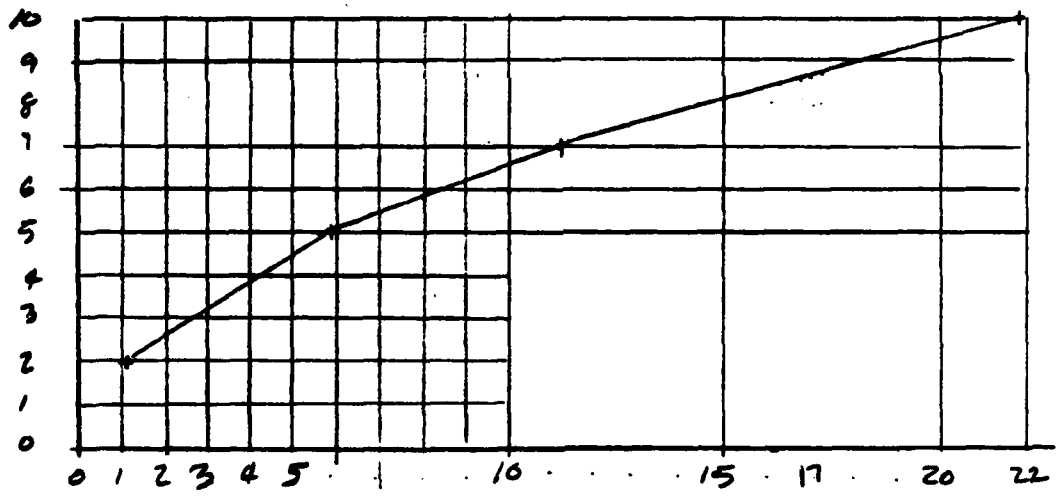
SHEET NO. D8
JOB DAMS
SUBJECT NOTOWN
CLIENT COE

Sta 30+00 (Goodfellow Pond)

$S = \frac{720-715}{1000} = 0.005$ ft/ft

$V = \frac{1.486}{0.06}(R^{2/3})(0.005)^{1/2} = R^{2/3}(1.75)$

D	WP	A	$R^{2/3}$	1.75	V	Q	El
2	250	960	1.5	"	2.63	1211	717
5	330	1330	2.54	"	4.45	5922	720
7	350	1995	3.21	"	5.62	11205	722
10	390	3105	4.01	"	7.02	21815	725



$Q_{P_1} = 17162$ $d_1 = 8.75$ $S_1 = \frac{2643}{1} \times \frac{1000}{43560} = 61$ c-f

$Q_{P_2} = 17162(1 - \frac{61}{3500}) = 16894$ $d_2 = 8.6$ $S_2 = \frac{2587}{1} \times \frac{}{} = 59$

$Q_{P_3} = 17162(1 - \frac{60}{3500}) = 16898$ cfs

$El_{\omega} = 723.65 \pm$

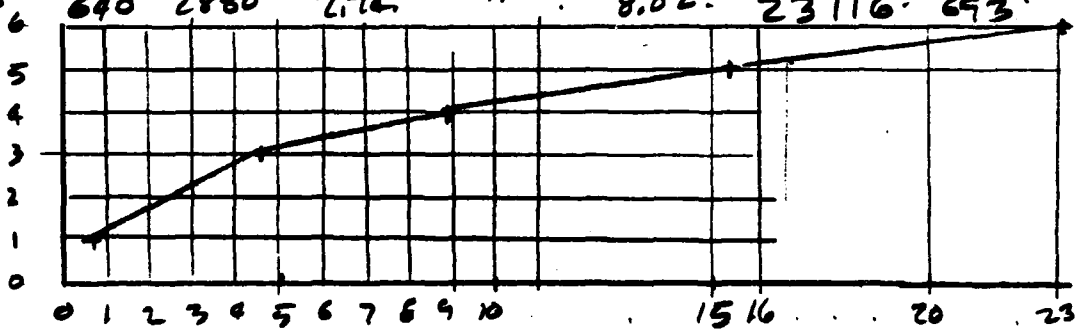
Std 50+00

$Q_{P_1} = 16,898.$

$S = \frac{28}{2000} = .014$ ft/ft

$V = \frac{1.486}{0.06} \cdot R^{2/3} (0.014)^{1/2} = R^{2/3} (2.93)$

D	WP	A	$R^{2/3}$	2.93 ·	V	Q	El
1	250	250	1	2.93 ·	2.93 ·	732. ·	688 ·
3	500	990	1.58 ·	"	4.63 ·	4584 ·	690
4	630	1620	1.88 ·	"	5.52 ·	8937 ·	691 ·
5	630	2250	2.346 ·	"	6.87 ·	15468 ·	692 ·
6	640	2880	2.74	"	8.02 ·	23116 ·	693 ·



$Q_{P_1} = 16,898 \cdot \quad d_1 = 5.2 \cdot \quad S_{t_1} = \frac{2376 + 2600}{2} \left(\frac{2000}{43560}\right) = 114$ ac-ft

$Q_{P_2} = 16,898 \cdot \left(1 - \frac{114}{3900}\right) = 16,404$ cfs

$d_2 = 5.1 \cdot \quad S_{t_2} = \frac{2250 + 2600}{2} (\quad) = 111$ ac-ft

$Q_{P_3} = 16898 \left(1 - \frac{1125}{3900}\right) = 16411 \cdot$ cfs

El = 692.2 ±

JOB NO. 79.206
DATE 12-3-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D10
JOB Ddmg
SUBJECT Returns
CLIENT COE

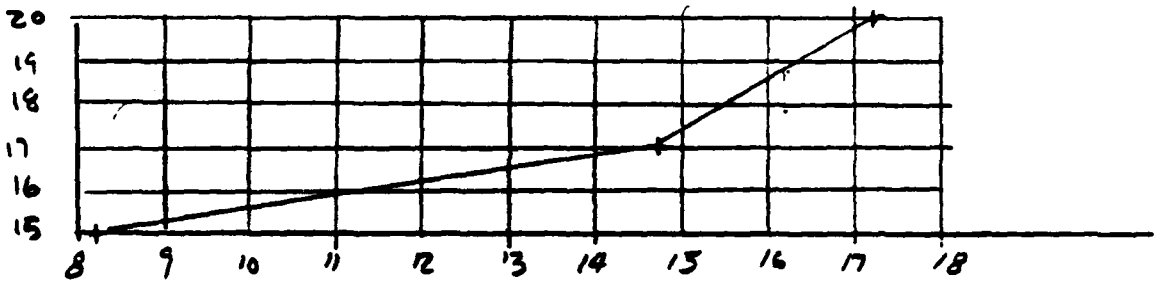
Sta 70+00

Q_{P_1} = 16411 · cfs n = 0.10 ·

$S = \frac{65}{2000} = 0.0325$ ft/ft

$V = \frac{1.486}{0.10} R^{2/3} (.0325)^{1/2} = 2.68 \cdot R^{2/3}$

D	WP	A	$R^{2/3}$	2.68 · V	Q	El
25	210	2312	5 ·	" ·	13.4	30968 · 630 ·
20	160	1462	4.4 ·	" ·	11.79 ·	17,240 · 625 ·
17	130	1220	4.49 ·	" ·	12.02 ·	14696 · 622 ·
15	120	825	3.71 ·	" ·	9.94 ·	8208 · 620 ·
5	50	125	1.85 ·	" ·	5 ·	618 · 610 ·



Q_{P_1} = 16,411 · d_1 = 18.8 · $Str_1 = \frac{1365 + 2250}{2}\left(\frac{2000}{43560}\right) = 83$ c.f.

$Q_{P_2} = 16,411\left(1 - \frac{83}{3900}\right) = 16062$ d_2 = 18.6 $Str_2 = \frac{1349 +}{2}(\ ) = 82.6$

$Q_{P_3} = 16411\left(1 - \frac{82.8}{3900}\right) = 16063$

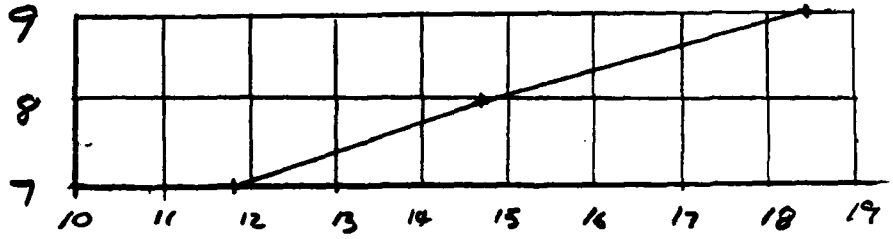
El ww. = 623.6 ±

Sta 75+00

$Q_{P_1} = 16063 \qquad S = \frac{30}{500.} = 0.06'/'.$

$V = \frac{1.486}{0.06} \cdot R^{2/3} (0.06)^{1/2} = R^{2/3} (6.07)$

D	WP	A	$R^{2/3}$	6.07	V	Q	EL
5	75	250	2.24	"	13.6	3400	580
7	105	605	3.23	"	19,6	11872	582
8	120	725	3.337	"	20.26	14686	583
9	125	845	3.598	"	21.84	18455	584



$Q_{P_1} = 16063 \quad d_1 = 8.3 \quad St_{r_1} = \frac{763 + 1355}{2} \left(\frac{500}{43560}\right) = 12.2$ cfs

$Q_{P_2} = 16063 \left(1 - \frac{12.2}{3400}\right) = 16,013$

$d_2 = 8.25 \quad St_{r_2} = \frac{756 +}{2} (\quad) = 12.1$

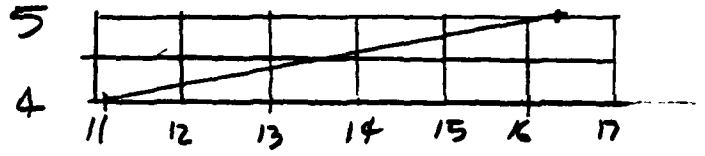
$Q_{P_3} = 16,013$ cfs Elev = 583.25±

Std 80+00

$Q_{P_1} = 16{,}013.$ cfs $\quad S = \frac{25'}{500'} = 0.05\%$

$V = \frac{1.486}{0.06}(R^{2/3})(.05)^{1/2} = R^{2/3}(5.54)$

D	WP	A	$R^{2/3}$	5.54	V	Q	EL
5	225	1050	2.81	"	15.6	16328	555
4	220	825	2.42	"	13.43	11080	554



$Q_{P_1} = 16{,}013. \quad d_1 = 4.9' \pm \quad Str_1 = \frac{1030+760}{2}\left(\frac{500}{43560}\right) = 10.3$

$Q_{P_2} = 16{,}013\left(1 - \frac{10.3}{3900}\right) = 15971.$

$d_2 = 4.8' \pm \quad Str_2 = \frac{1005+}{2}(\quad) = 10.1$

$Q_{P_3} = 16{,}013\left(1 - \frac{10.2}{3900}\right) = 15971$

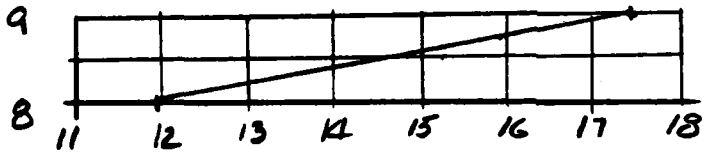
Elev = 554.9 ±

Sta 85+00

$Q_{P_1} = 15971$ $S = \frac{10}{1000} = 0.01$ ft/ft

$V = \frac{1.486}{0.06} R^{2/3} (0.01)^{1/2} = 2.48 \cdot R^{2/3}$

D	WP	A	$R^{2/3}$	2.48 · V	Q	El.
5	300	750	1.85 ·	" ·	4.58 ·	3437 · 510 ·
10	650	3250	2.94 ·	" ·	7.29 ·	23694 · 515 ·
8	570	2050	2.36 ·	" ·	5.84 ·	11985 ·
9	600	2620	2.68 ·	" ·	6.66 ·	17444 ·



$Q_{P_1} = 15971$ $d_1 = 8.75$ ·

$St_{r_1} = \frac{2478 + 1010}{2} \cdot \left(\frac{500}{43560}\right) = 20$ ·

$Q_{P_2} = 15971 \left(1 - \frac{20}{3900}\right) = 15889$ ·

$d_2 = 8.7$ · $St_{r_2} = \frac{3900 +}{2} \{\ \} = 19.6$ ·

$Q_{P_3} = 15971 \cdot \left(1 - \frac{19.8 \cdot}{3900 \cdot}\right) = 15,890$ · cfs

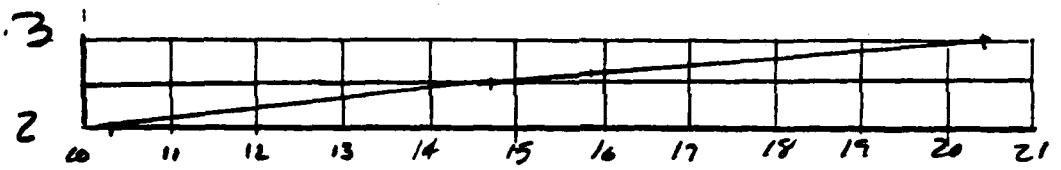
Elw 513.75

Sta 90+00

$Q_{PF} = 15890$ $S = 0.01$ $n = 0.06$

$V = \frac{1.486}{0.06} R^{2/3} \sqrt{.01} = R^{2/3}(2.48')$

D	W	A	$R^{2/3}$	2.48.	V	Q	EL.
4	1950	5400	2.41.	"	6.	32,317.	504.
2	1350	2650	1.57.	"	3.9.	10,327.	502.
2.5	1375	3300	1.8.	"	4.6.	14,713.	
3	1400	4050	2.04.	"	5.05.	20464.	503.



$Q_{P_1} = 15890$ $d_1 = 2.6\pm$ $Sta_1 = \frac{3400+2450}{2}(\ ) = 33.6$

$Q_{P_2} = 15,890.\left(1 - \frac{33.6}{3900}\right) = 15753.$

$d_2 = 2.5\pm$ $Sta_2 = \frac{3300+}{2} = 33$

$Q_{P_3} = 15890\left(1 - \frac{33.3}{3900}\right) = 15,754.$ cfs

$El_{ew} = 502.5\pm$.

JOB NO. 79.206.1
DATE 12-6-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

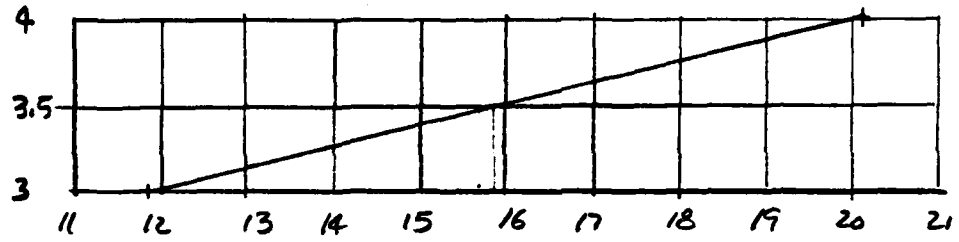
SHEET NO D15
JOB DAMS
SUBJECT NOTOWN
CLIENT COE

Sta 100+00

$Q_{P_1} = 15754 \quad S = \frac{20}{1000} = 0.02'/'$

$V = \frac{1.486}{0.06} \cdot R^{2/3}\sqrt{.02} = R^{2/3}(3.51)$

D	WP	A	$R^{2/3}$ (3.5)	V	Q	El
5	700	3100	2.71	"	9.49	29405	485
3	635	1725	1.99	"	6.84	11793	483
2	610	1150	1.53	"	5.35	6155	482
4	665	2420	2.38	"	8.31	20126	484



$Q_{P_1} = 15754 \quad d_1 = 3.5' \pm \quad St_1 = \frac{2073 + 3350}{2}\left(\frac{1000}{4356}\right) = 62.2$

$Q_{P_2} = 15754\left(1 - \frac{62.2}{3900}\right) = 15503$

$d_2 = 3.45 \pm \quad St_2 = \frac{2043 +}{2}(\ ) = 61.9$

$Q_{P_3} = 15754\left(1 - \frac{62.05}{3900}\right) = 15503.$

$El_W = 483.5 \pm .$

JOB NO. 79.206
DATE 12-6-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D16
JOB DAMS
SUBJECT NOTOWN
CLIENT COE

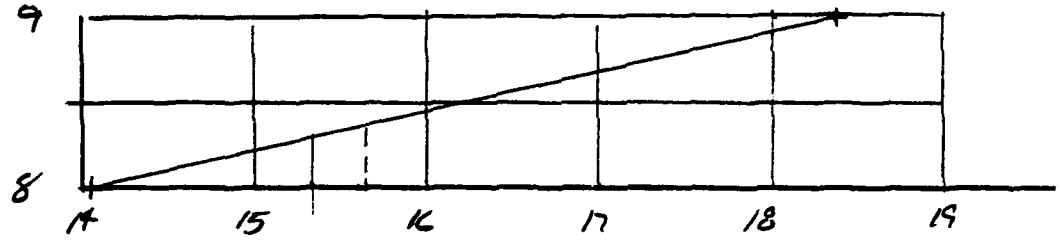
MAIN DAM

Sta 110+00

Q_{P_1} = 15503 cfs $S = \frac{2}{1000} = 0.002'/'$

$V = \frac{1.486}{.06} R^{2/3} \sqrt{.002} = R^{2/3}(1.11)$

D	WP	A	$R^{2/3}$	(1.11) ·	V	Q	
4	600	1440	1.8	"	2	2880	
6	880	2860	2.29	"	2.54	7272	484
10	1230	6860	3.16	"	3.51	24088	488
8	1050	4660	2.714	"	3.01	14039	486
9	1150	5670	2.91	"	3.23	18329	



Q_{P_1} = 15503 d_1 = 8.4 $S_{f_1} = \frac{564 + 2060}{2}\left(\frac{1000}{48360}\right)$

= 81.8

$Q_{P_2} = 15503\left(1 - \frac{81.8}{3900}\right) = 15178$

d_2 = 8.25 $S_{f_2} = \frac{4913+}{2}(\ ) = 80.0$

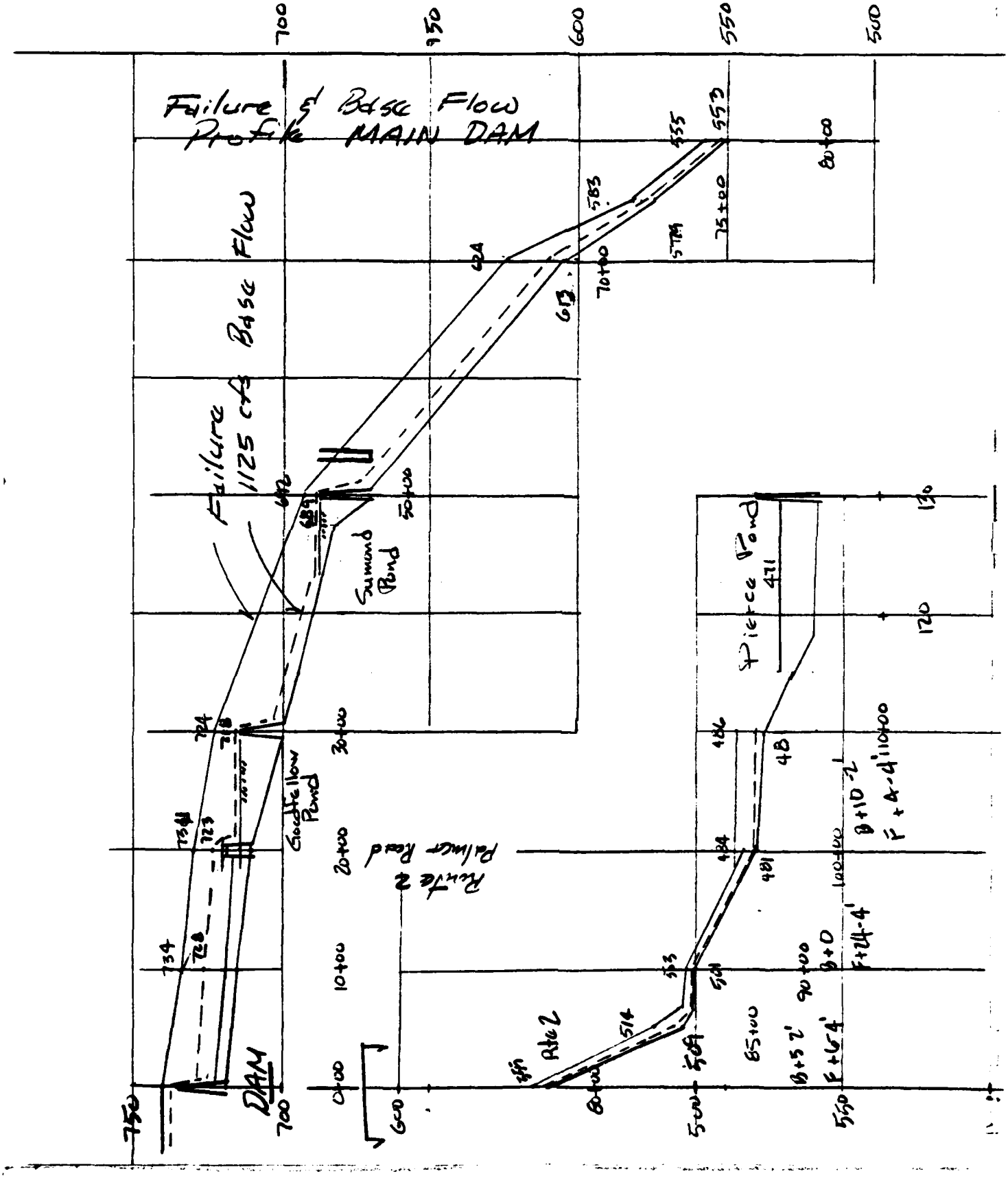
$Q_{P_3} = 15503\left(1 - \frac{80.8}{3900}\right) = 15,182$ cfs

Elev = 486.3' ±

JOB NO. 792061
DATE 1-07-80
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D16a
JOB Dams
SUBJECT Hydrau
CLIENT COE



JOB NO. 79.206.1
DATE 1-08-80
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D16b
JOB Dams
SUBJECT Notown
CLIENT Ct DEP

Main Dam

Station	Elev	Base Flow Stage Elev	Failure & Base Stage Elev
0+00	719.5	—	740.6
10+00	720	728	734
20+00	720	723	730
30+00	715	718	724
50+00	687	689	692
70+00	605	613	624
75+00	515	579	583
80+00	550 Rte 2	553	555
85+00	505 550± Rte 2 523±	509	514
90+00	500	501	503
100+00	480	481	484 * BW
110+00	478	481	486±

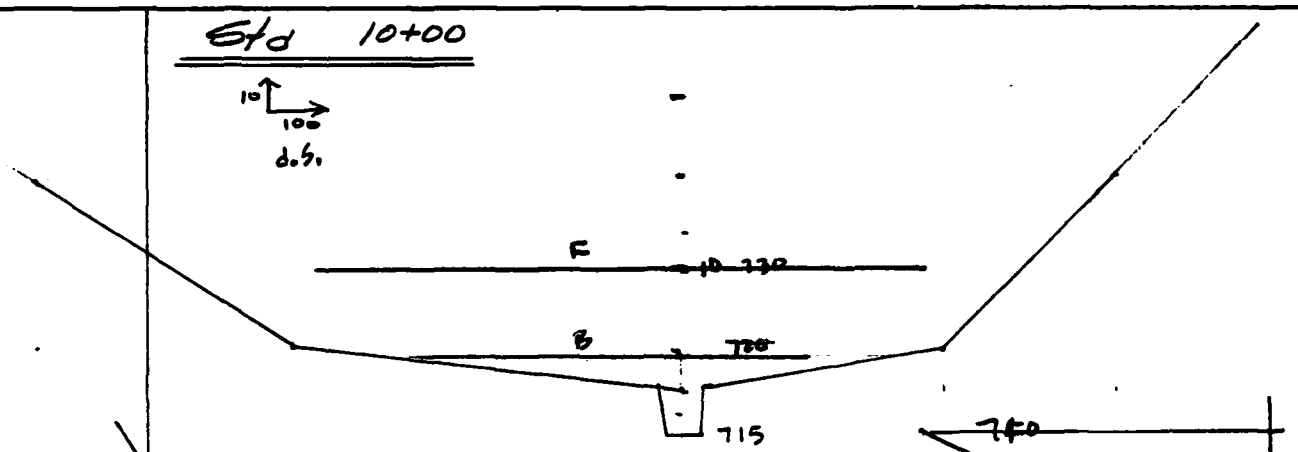
JOB NO. 79.206.1
DATE 11-5-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

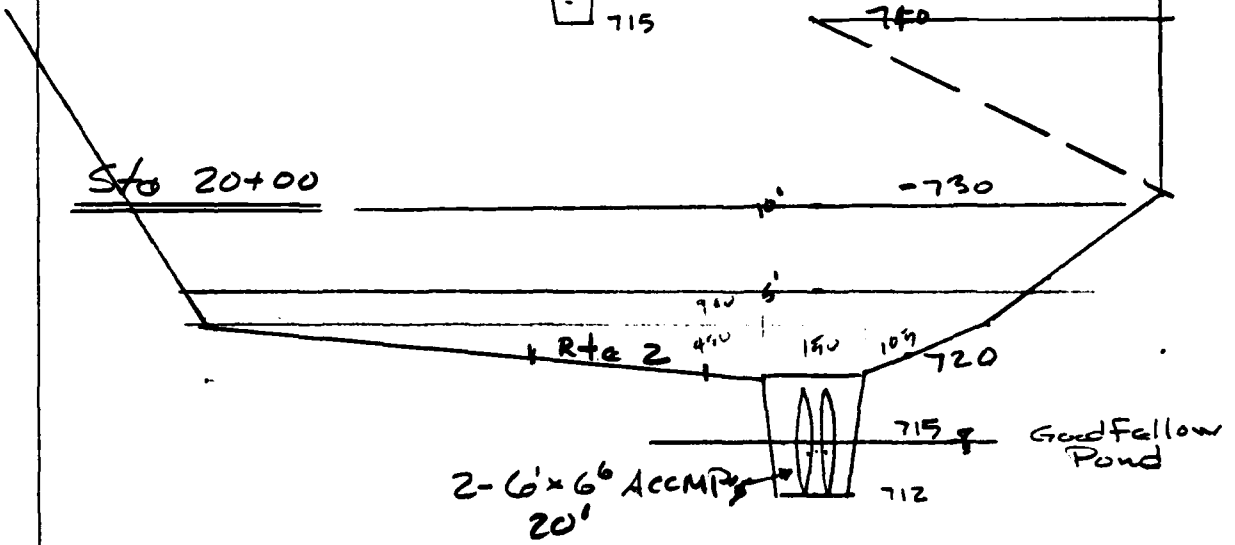
SHEET NO. 17
JOB Dams
SUBJECT Notown Res.
CLIENT COE

Sta 10+00 to 110+00 ARE FOR MAIN DAM

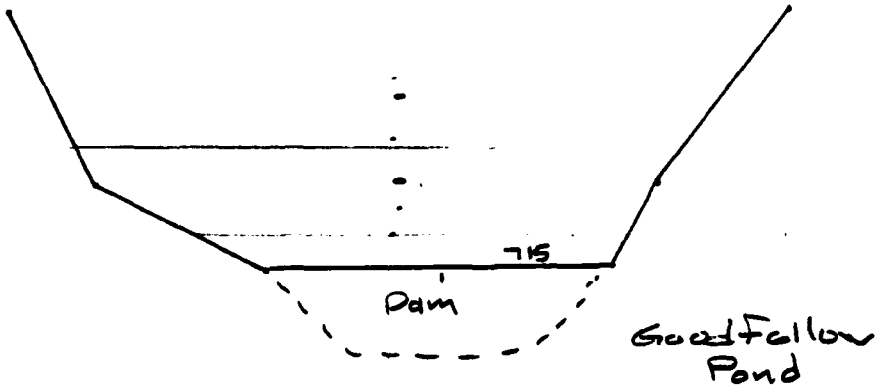
Sta 10+00



Sta 20+00



Sta 30+00

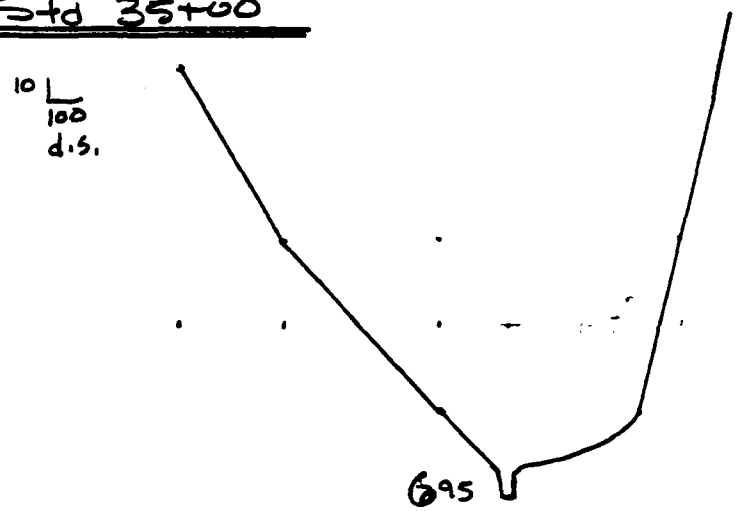


JOB NO. 79.206.1
DATE 11-5-79
BY MA
CH'D BY FDD

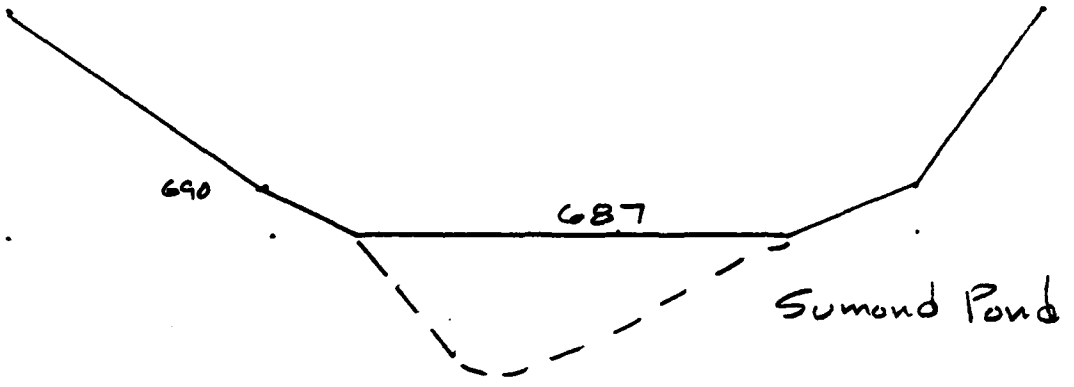
HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO D18
JOB Dams
SUBJECT Natown
CLIENT COE

Std 35+00



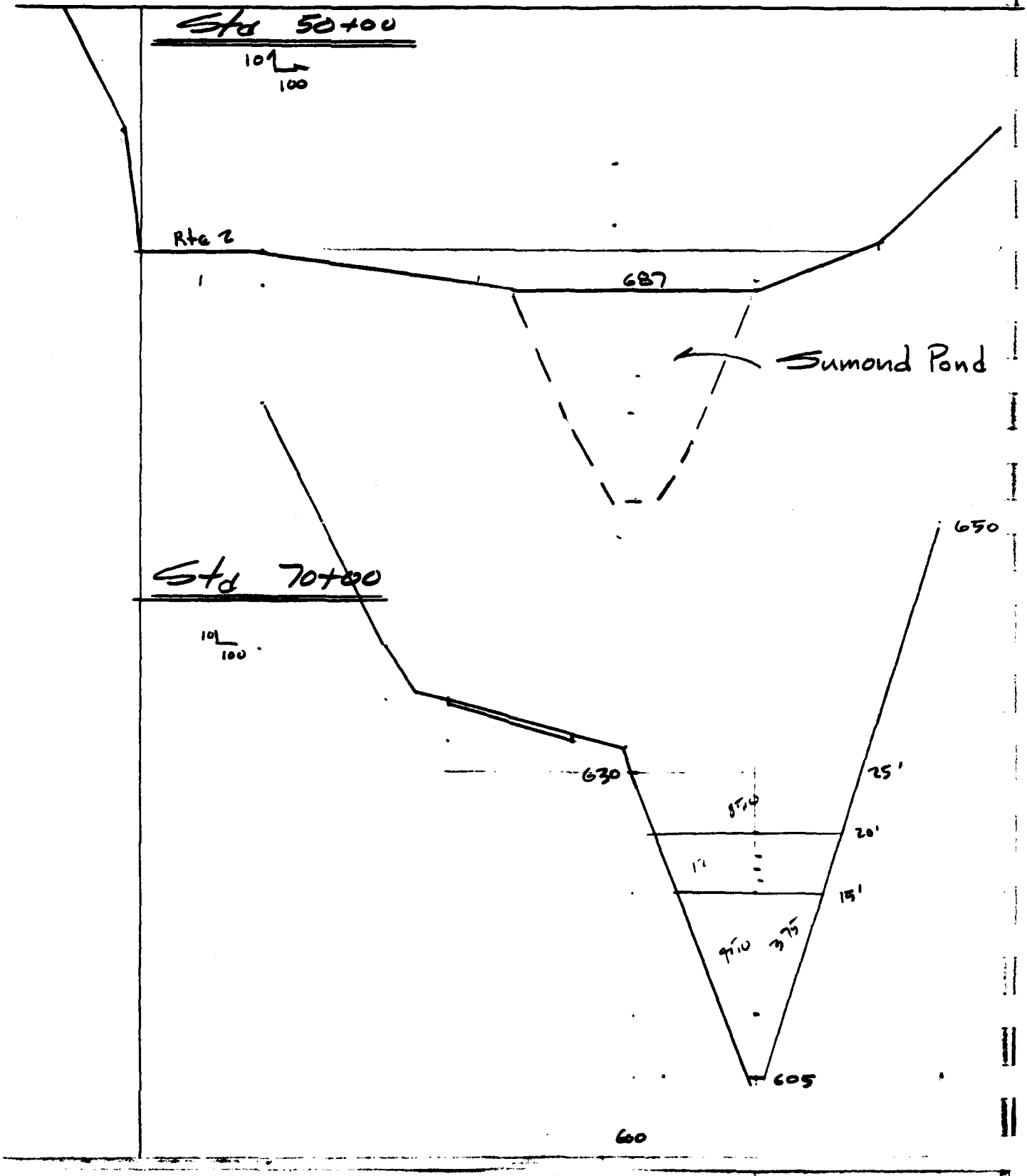
Sta 47+50 (50+00)



JOB NO. 79206.1
DATE 12-3-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

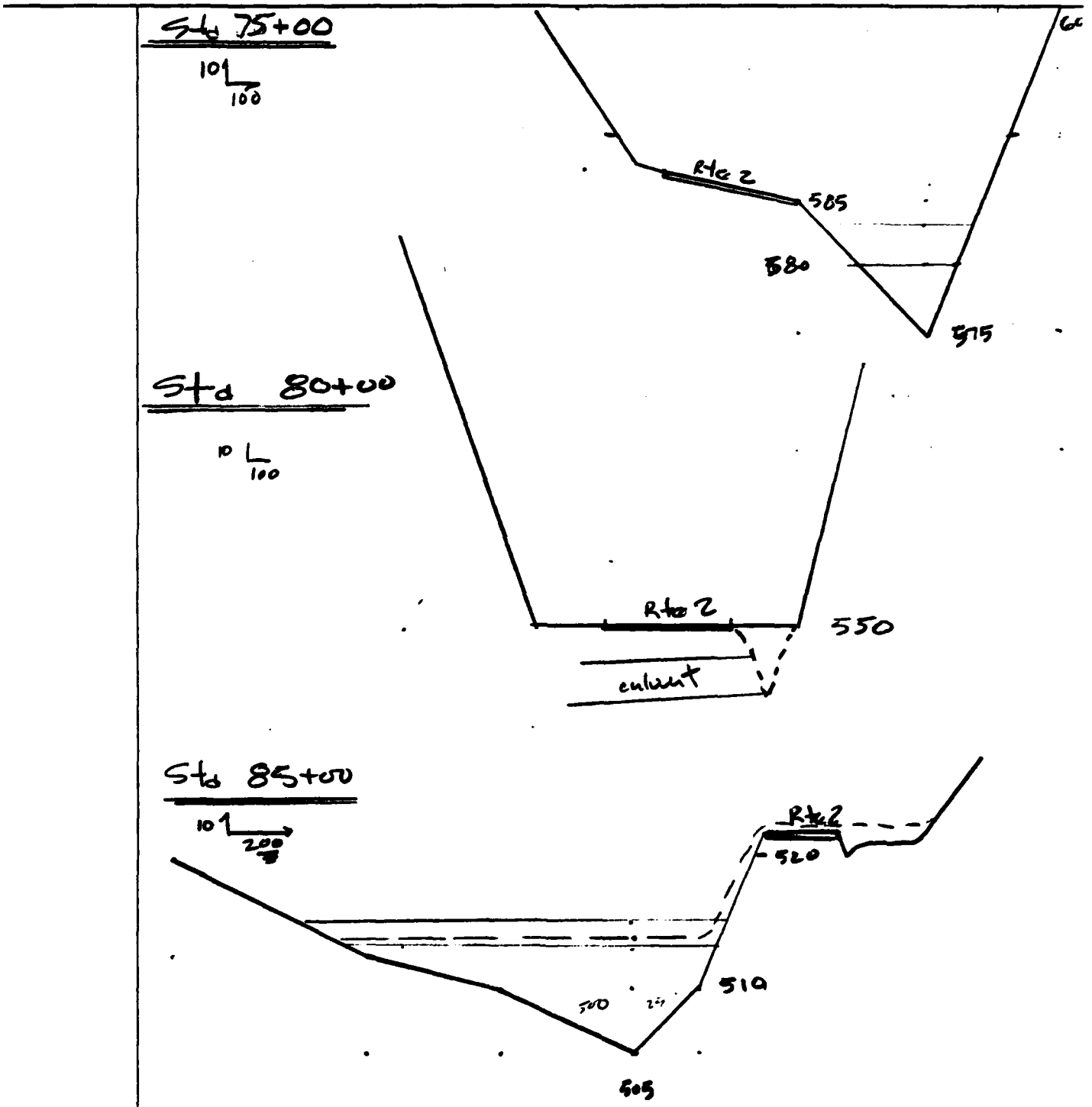
SHEET NO. D19
JOB DAMS
SUBJECT NOTOWN
CLIENT COE



JOB NO. 79.206.1
DATE 12-5-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

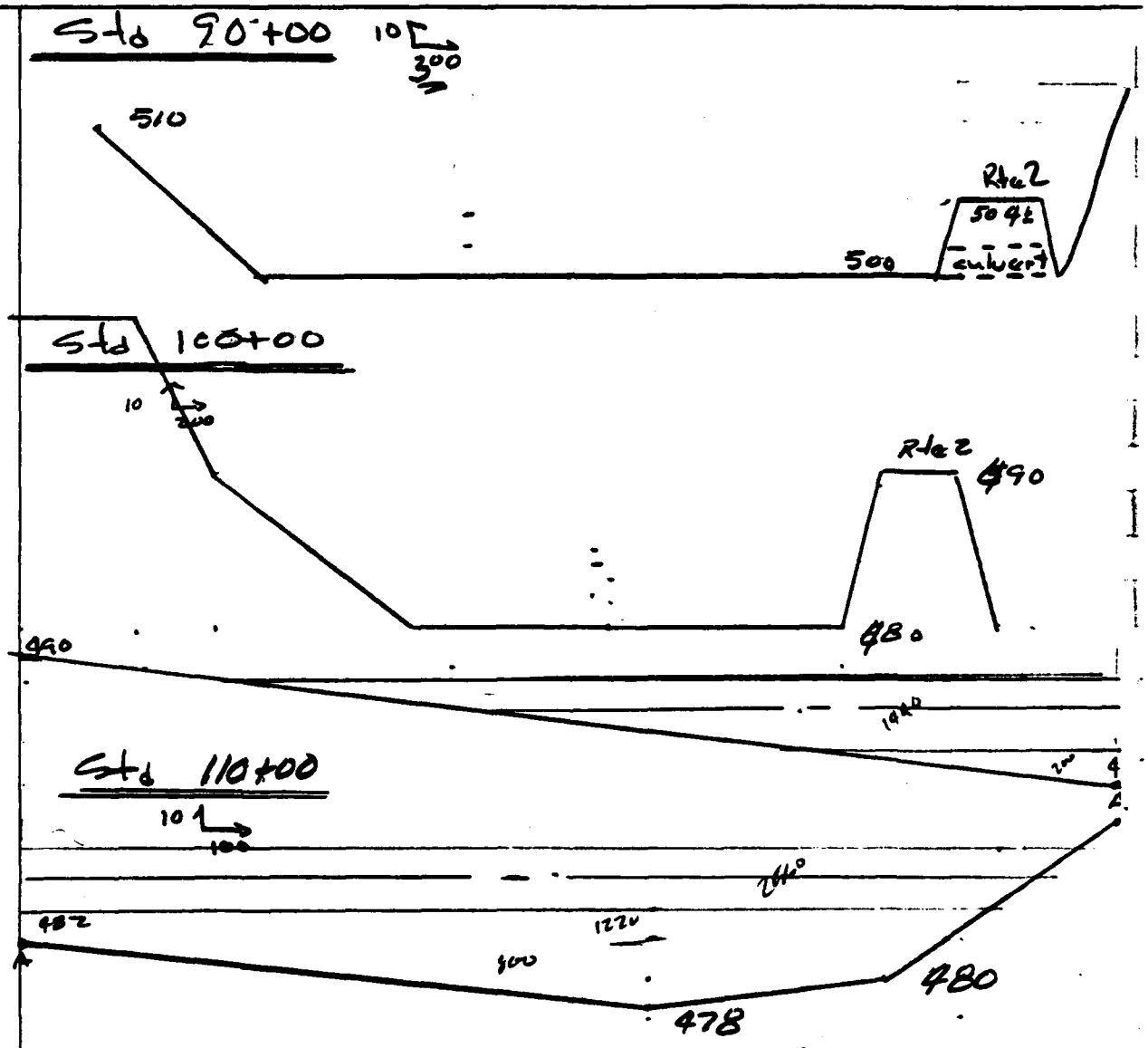
SHEET NO. D20
JOB Dams
SUBJECT No town
CLIENT COE



JOB NO. 79,206,1
DATE 12-5-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D 21
JOB Dams
SUBJECT Dutton
CLIENT COE



JOB NO. 79.206.1
DATE 12-6-79
BY MA
CH'D BY PDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

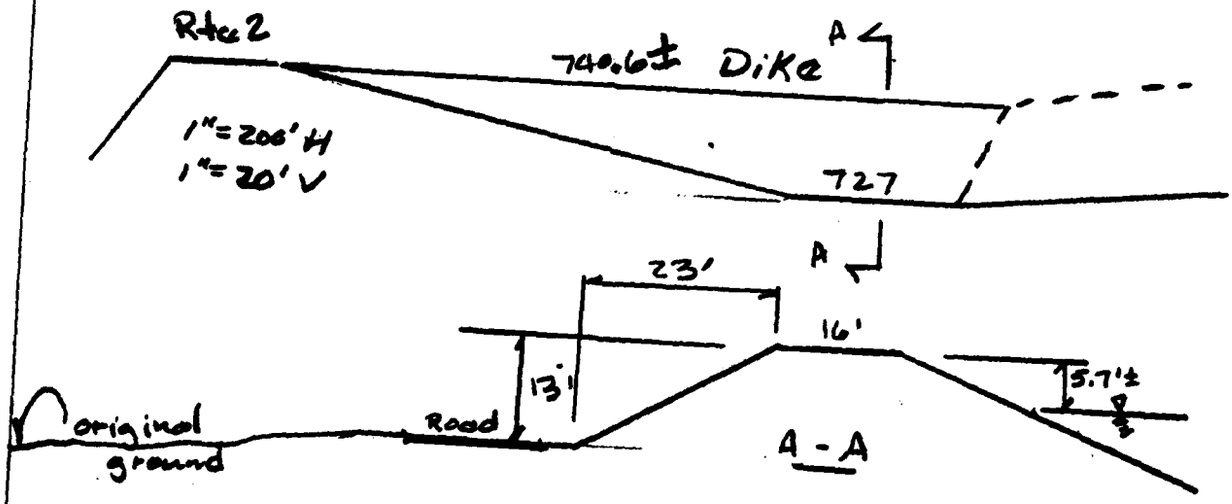
JOB DAMS SHEET NO. R22
SUBJECT NOTOWN - DIKE
CLIENT COE

"DIKE AREA" Pgs 22 to 30

FAILURE DISCHARGE

Water level at top of dike, elev at time of failure. Dike has no spillway or outlet works, therefore, no base flow condition.

$Q_F = \frac{8}{27} \times (0.4 \times 400)\sqrt{32.2}\,(13)^{1.5} = 12{,}600 \pm$ cfs



Storage Capacity

Elev. 740.6 3900.

Elev 727.0 -994.

Diff = 2900 ± a.f

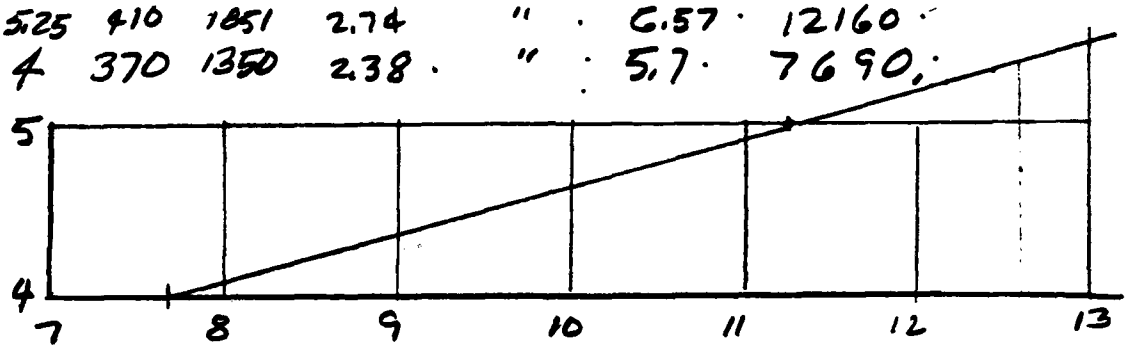
Test Flood = PMF see main dam calcs.

Sta 7+50

$Q_A = 12,600.^{\pm}$ cfs $n = 0.06$ $S = \frac{7}{750.} = 0.0093$

$V = \frac{1.486}{0.06} \cdot R^{2/3} (0.0093) = R^{2/3}\ 2.393$

D	WP	A	$R^{2/3}$ (2.393)	V	Q	El
5	400	1750	2.7	"	6.43	11257
5.25	410	1851	2.74	"	6.57	12160
4	370	1350	2.38	"	5.7	7690



$Q_{P_1} = 12600.$ $d_1 = 5.4$

$Stor_1 = 1956 \left(\frac{750}{43560}\right) = 33.57$ a-f

$Q_{P_2} = 12600. \left(1 - \frac{33.57}{2900}\right) = 12454$ cfs

$d_2 = 5.3$ $Stor_2 = 1900 (\quad) = 32.7$

$Q_{P_3} = 12600 \left(1 - \frac{33.14}{2900}\right) = 12456$ cfs

Elev = 725.4 ±

JOB NO. 79.206
DATE 12-6-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

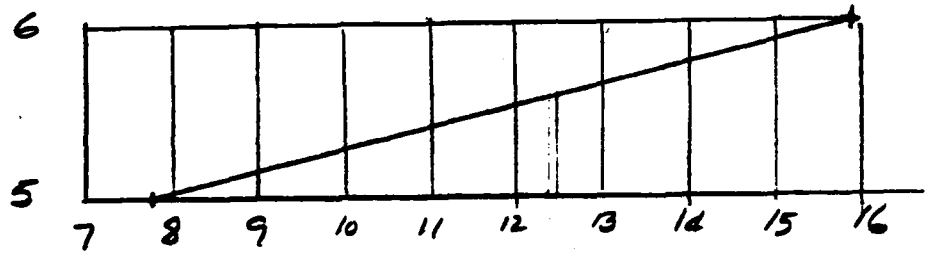
SHEET NO. R24
JOB DAMS
SUBJECT NOTOWN-DIKE
CLIENT COE

Sta 15+00

$Q_{P_1} = 12,456.$ $\quad S = \frac{720-665}{750} = 0.073$ ft/ft

$V = \frac{1.486}{0.06} R^{2/3} \sqrt{.073} = R^{2/3}(6.71)$

D	W	A	$R^{2/3}$	(6.71)	V	Q	
15	350	3625	4.79	"	32.1	116,477	680
5	250	625	1.85	"	12.39	7749	670
6	260	975	2.42	"	16.21	15860	



$Q_{P_1} = 12456$ $\quad d_1 = 5.6$ $\quad Sf_1 = \frac{835+1900}{2}\left(\frac{750}{43560}\right) = 23.54$

$Q_{P_2} = 12456.\left(1 - \frac{23.54}{2900}\right) = 12355.$

$d_2 = 5.55$ $\quad Sf_2 = \frac{825+}{2}(\ ) = 23.46.$

$Q_{P_3} = 12456\left(1 - \frac{23.5.}{2900}\right) = 12355.$

Elev = 670.5 ±

JOB NO. 79.206.1
DATE 12-6-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

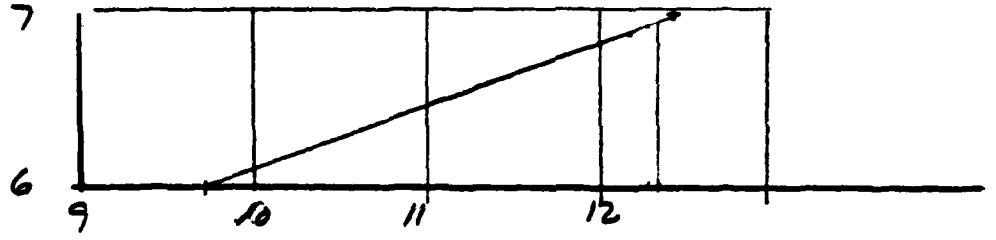
SHEET NO. D25
JOB DAMS
SUBJECT NOTOWN-DIKE
CLIENT COE

Std 25+00

$Q_{P_1} = 12355 \cdot \quad S = \frac{5}{1000} = 0.005 \cdot 1/1$

$V = \frac{1.486}{0.06} \cdot R^{2/3} \sqrt{.005} = R^{2/3} (1.75)$

D	WP	A	$R^{2/3}$	(1.75)	V	Q	Elev
5	410	1600	2.49	"	4.36	6972	665
7	500	2450	2.9	"	5.07	12434	667
6	450	2025	2.74	"	4.8	9708	666.



$Q_A = 12355 \quad d_1 = 6.9' \quad Sf_1 = \frac{2405 + 830}{2}\left(\frac{1000}{93560}\right) = 37.L$

$Q_{P_2} = 12355\left(1 - \frac{37.L}{2900}\right) = 12,197. \text{ cfs}$

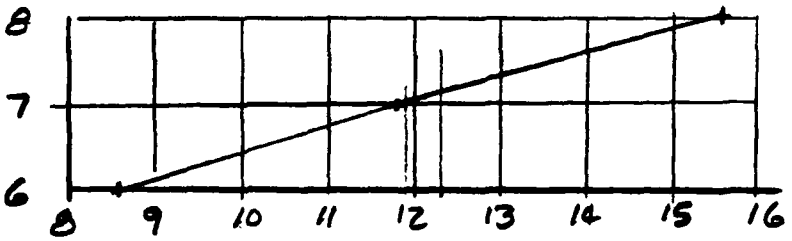
$d_2 = 6.9 \pm \cdot \quad Q_{P_3} = 12200$

Elev. 667 ±.

Sta 47+00

$Q = CLH^{1.5} = 2.6\,LH^{1.5}$ $\quad Q_T = 12{,}200\pm cfs$

D	C	L	$H^{1.5}$	Q
4	2.6	170	8.	3536.
8	"	265	22.63.	15590.
6	"	225	14.7.	8597.
7	"	245	18.52.	11797.



$Q_{P_1} = 12200$. $d_1 = 7.1'$. $Sf = 1721\left(\frac{2200}{93560}\right) = 87$ c-f

$Q_{P_2} = 12200\left(1 - \frac{87}{2900}\right) = 11{,}834.$ cfs

$d_2 = 7'$. $Sf = 1685\left(\frac{2200}{93560}\right) = 85$.

$Q_{P_3} = 12200\left(1 - \frac{85}{2900}\right) = 11{,}842.$ cfs

Elev = 647.

JOB NO. 79.206.1
DATE 12-7-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

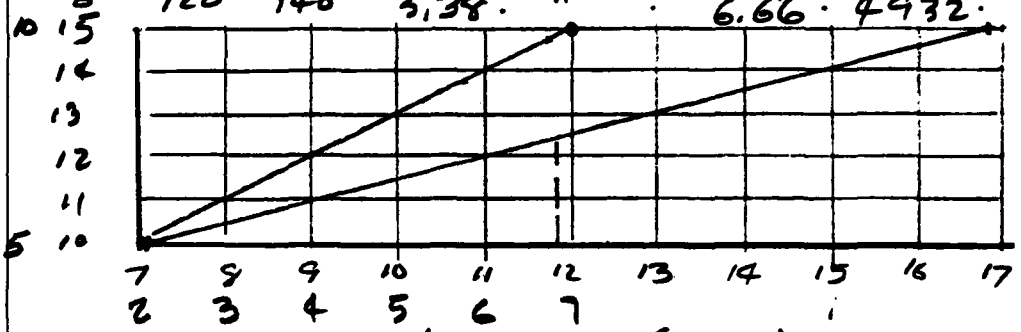
SHEET NO. D 27
JOB DAMS
SUBJECT NOTOWN-DIKE
CLIENT COE

Std 52+00

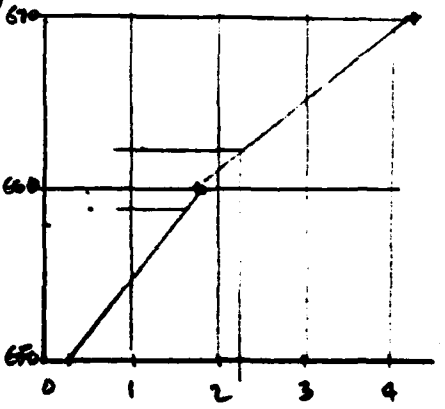
$Q_{PA} = 11,842.$ cfs $\quad V = \frac{1.486}{.04} R^{2/3} \sqrt{.0028}$

$S \approx \frac{7}{2500} = 0.0028$

D	WP	A	$R^{2/3}$	(1.97)	V	Q
5	100	400	2.5	"	5	2000
10	150	1000	3.56	"	7.02	7022
3	90	210	1.76	"	3.48	730
15	350	2325	3.56	"	7.02	16321
8	120	740	3.38	"	6.66	4932



$Q_{PA} = 11,843.$ $\quad d_1 = 12.4$ $\quad (662.4)$



$Stor_1 = 2500$ d-f $\simeq 2900$ d-f

Elev	Area	A_n	Stor	Cum Stor
647	83	—	—	— —
650	103	93.	279.	279.
660	193	148.	1480.	1759.
670	308	250.	2500	4259.

$Stor_1 = 2500$ a-f ∴ $Stor_2 = \frac{2500+0}{2} = 1250$

$Q_{P_3} = 11842\left(1 - \frac{1250}{2900}\right) = 6738$ cfs

$El_3 = 9.75'$ (elev = 659.75)

$Stor_3 = 1700$ $Stor_{ave} = \frac{1200+1250}{2} = 1475$

$Q_{P_4} = 11842\left(1 - \frac{1475}{2900}\right) = 5820\pm$ (659.75)

$El_4 = 8.75$ $Stor_4 = 1600$ $Stor_{ave} = 1540\pm$

$Q_{P_5} = 11842\left(1 - \frac{1540}{2900}\right) = 5553$

$El_5 = 8.5$ (658.50) $Stor_5 = 1500$ ave = 1520

$Q_{P_6} = 11842\left(1 - \frac{1520}{2900}\right) = 5635$ cfs

$El_6 = 8.65\pm = 658.65$ ok

$659\pm$

JOB NO. 792061
DATE 10808
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO P-275
JOB DAMS
SUBJECT Notown - Dike
CLIENT COE

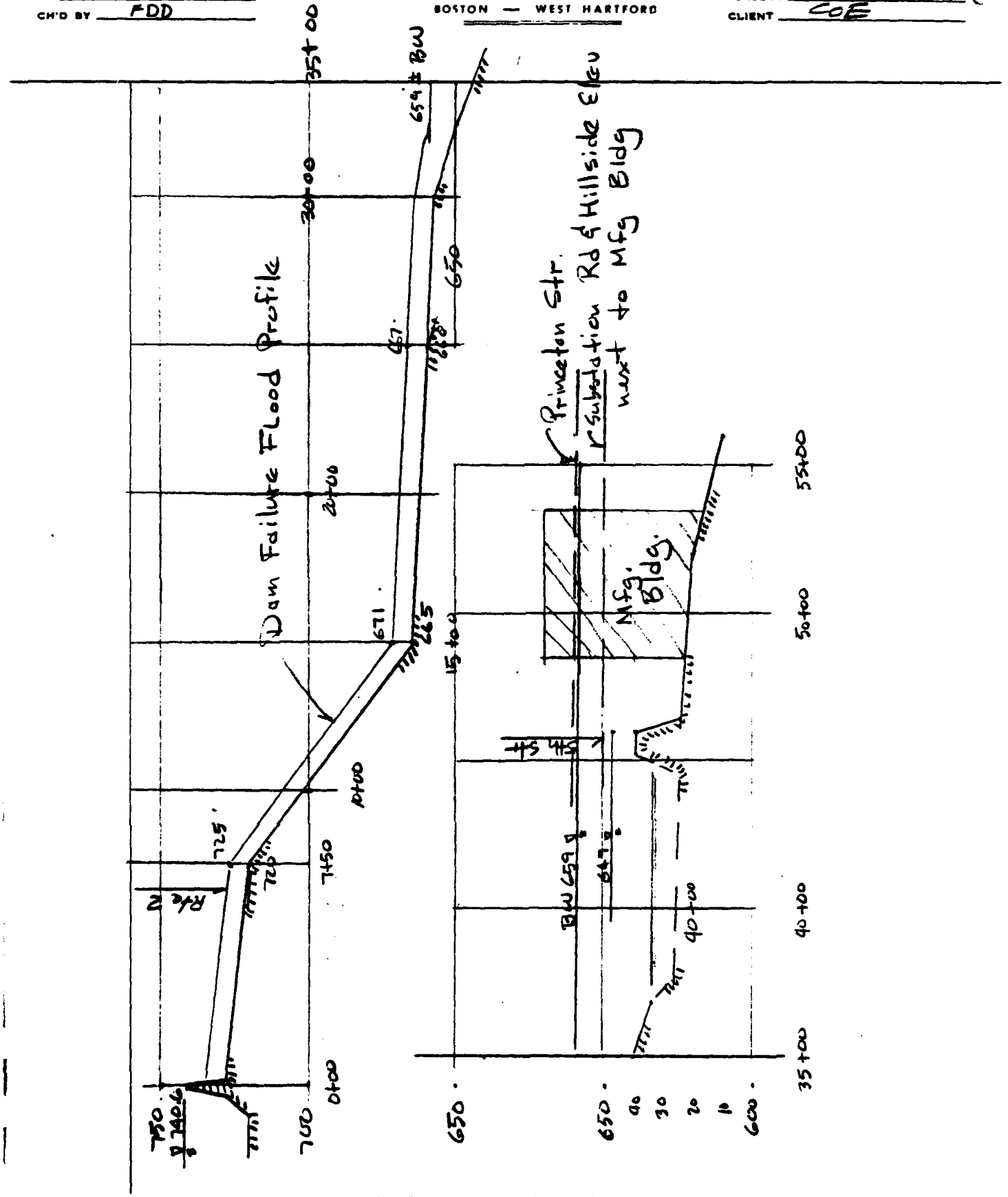
Sta	Elev - Grnd	Flood Elev	Damage
1+00	727.	734.	1 House 1 to 2'±
1+00 to 5+00	727 to 722,	734 to 725.	Junk Yard 5'±
5+00 to 7+50	720±	725.	Rte 2 5'±
			Oak Hill Rd 5'±
	715±		Barn 10'±
7+50 to 25+00	Varies	Varies.	Power Lines 5'±
22+00 to 40+00	Varies	Varies.	Rte 2 5' to 8'±
30+00 to 40+00	636 (Pond)	659. BW	Substation 3' to 5'±
			2 houses 3'±
			1 " 8'±.
40+00 to 50+00	Varies	659.	6 houses 4'±
			4 " 8'+
			1 Mfg Bldg 30'±
			5th Str. 20'±

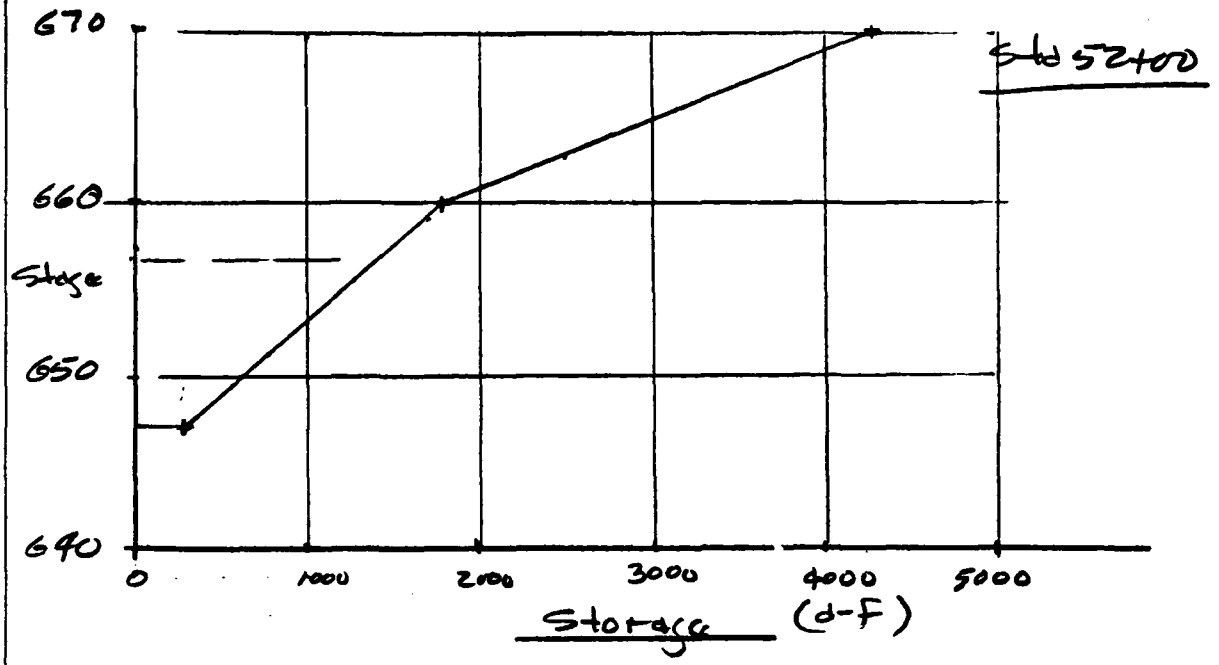
50+00 on foreward Addition damage at industrial & residential dreds as remaining flow 5635cfs is dissipated.

JOB NO. 792061
DATE 1-08-80
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D 27c
JOB Dams
SUBJECT Notown Dike
CLIENT COE

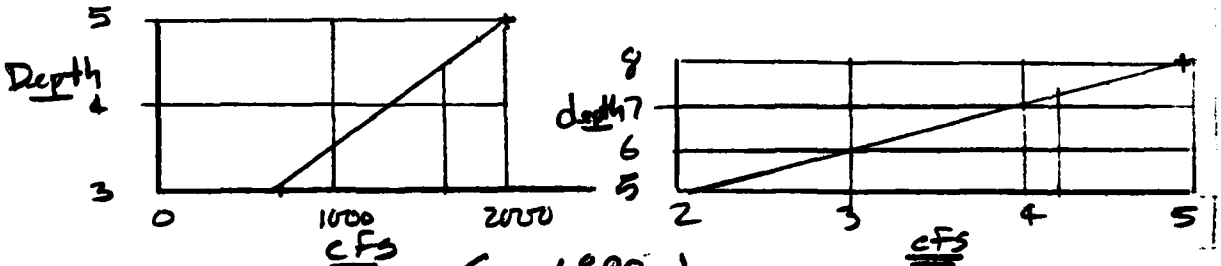




Q_{P_1} = 11842 El_1 = 662.4 Str_1 = 2450 a-f

$Q_{P_2} = 11842\left(1 - \frac{2450}{2900}\right) = 1837.$

El_2 = 654.7 ± Str_2 = 1150 a-f



$Q_{P_3} = 11{,}842.\left(1 - \frac{1800}{2900}\right) = 4{,}492.$ cfs

Elev = 657.5 ±

(assumes building is not washed-away)

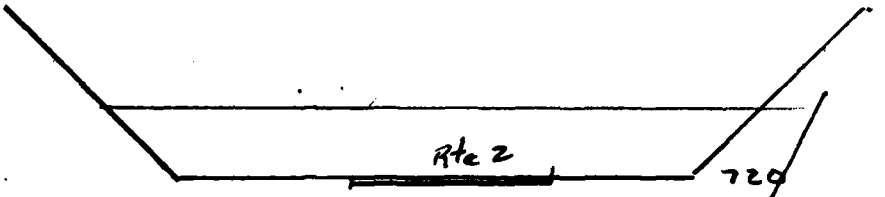
JOB NO. 79.206.1
DATE 12-6-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D-25
JOB Dams
SUBJECT NO TOWN - DIKE
CLIENT COE

Sta 7+50

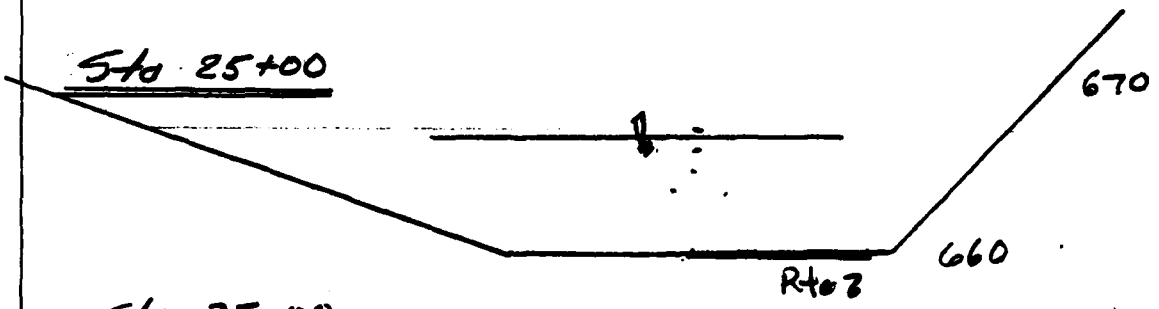
10 L 100



Sta 15+00

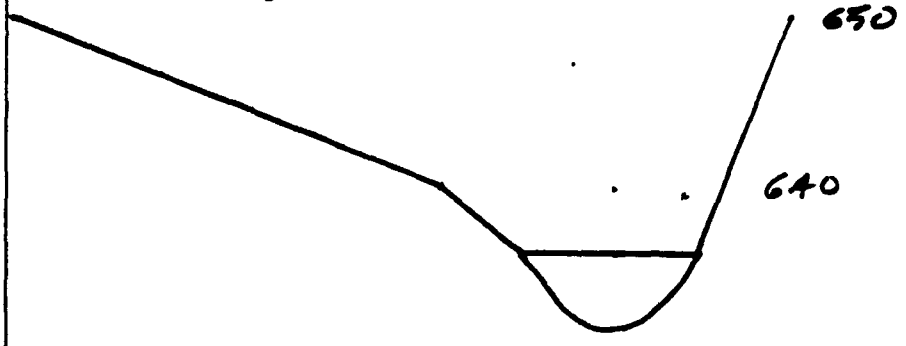
10 L 100

Sta 25+00



Sta 35+00

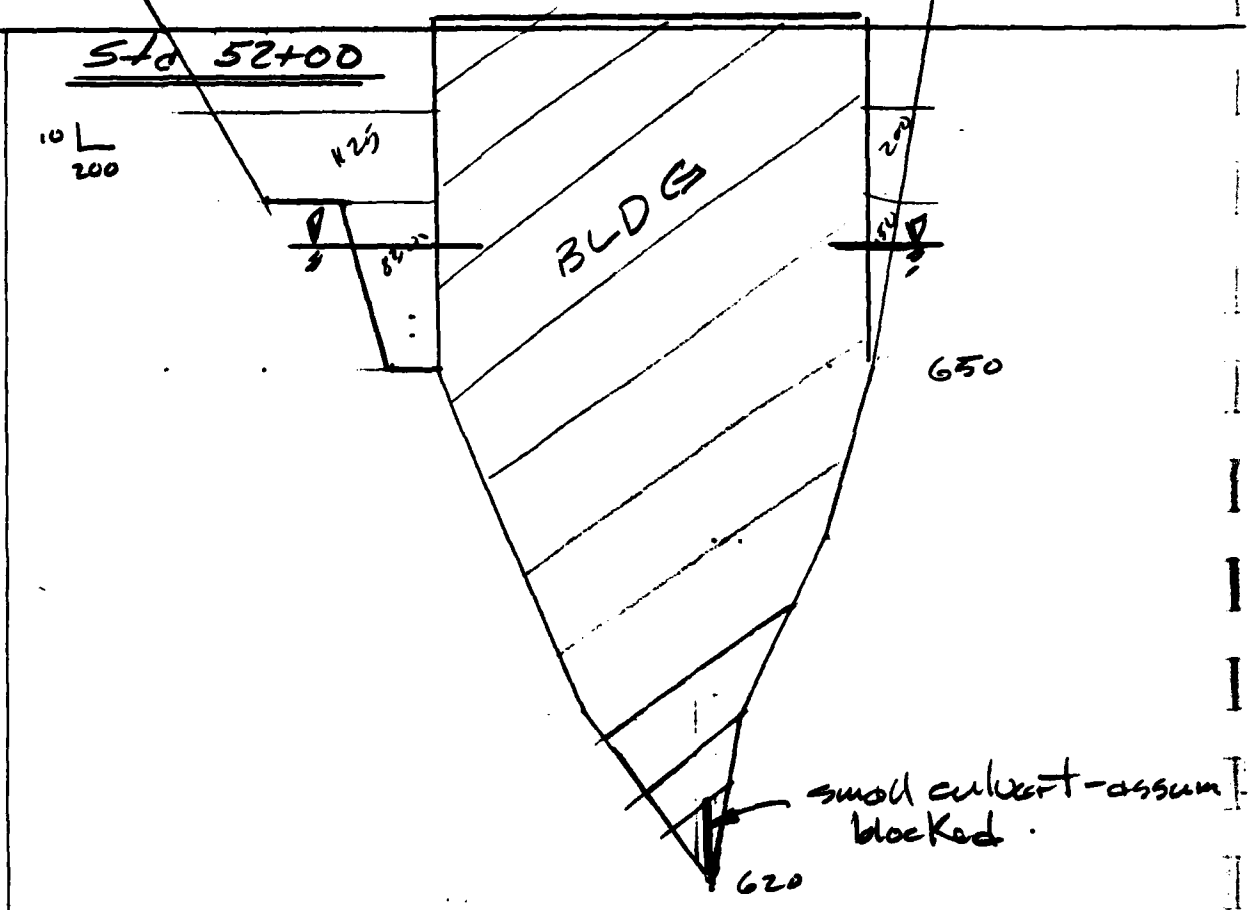
10 L 100



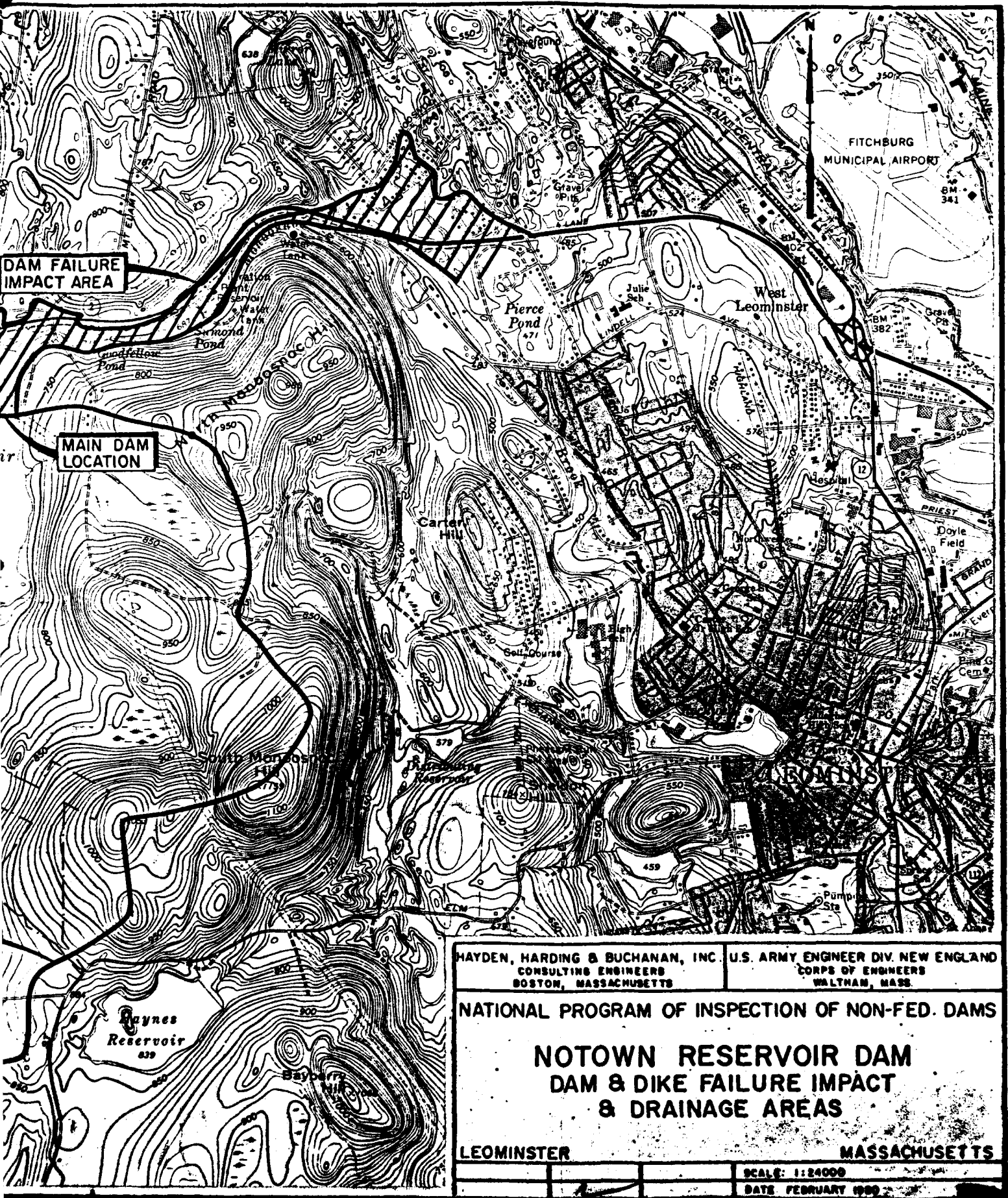
JOB NO. 79.206.1
DATE 12-7-79
BY MA
CH'D BY FDD

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D30
JOB DAMS
SUBJECT NOTOWN-DIKE
CLIENT COE




DIKE FAILURE
IMPACT AREA
DAM FAILURE
IMPACT AREA
DIKE LOCATION
MAIN DAM
LOCATION
Notown Reservoir
DRAINAGE AREA
Sawmill
Pond
Rocky
Pond
Goodfellow
Pond
Rice Meadow
Snows Millpond
River
WESTMINSTER
BOUNDARY
LEOMINSTER
STATE FOREST
STREET



HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

NOTOWN RESERVOIR DAM
DAM & DIKE FAILURE IMPACT & DRAINAGE AREAS

LEOMINSTER MASSACHUSETTS

SCALE: 1:24000

DATE FEBRUARY 1980

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(6) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY / MO / YR
MA	870	NED	MA	027	04				NOTOWN RESERVOIR DAM	4232.5	7149.0	15FEB80

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	NOTOWN RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	06	MONOOSNOC BROOK	LEOMINSTER	0	33000

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(26) IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)
ERGOT	1876	S	23	21	3900	2500

DIST	OWN	FED R	PRV/FED	SCS A	V&B/C
NED	N	N	N	N	

(27) REMARKS
21 STEEL + CONCRETE CUTOFF WALL 22 APPROX

(28) D/S HAS	(29) SPILLWAY CREST LENGTH	(30) SPILLWAY TYPE	(31) SPILLWAY WIDTH (FT.)	(32) MAXIMUM DISCHARGE (FT.)	(33) VOLUME OF DAM (CY)	(34) POWER CAPACITY INSTALLED (MW)	(35) POWER CAPACITY PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	600	C	49	1900	30000											

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
CITY OF LEOMINSTER	METCALF + EDDY	UNKNOWN

(49) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(50) INSPECTION BY	(51) INSPECTION DATE DAY / MO / YR	(52) AUTHORITY FOR INSPECTION
HAYDEN, HARDING + BUCHANAN, INC.	24OCT79	PUBLIC LAW 92-367

(53) REMARKS
31-PROVISIONS FOR FLASHBOARDS 47-1930

INVENTORY OF DAMS IN THE UNITED STATES

(1) IDENTITY NUMBER	(2) DIVISION	(3) STATE	(4) COUNTY	(5) CONGR DIST.	(6) STATE	(7) COUNTY	(8) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
1240	NED	MA	027	04				NOTOWN RESERVOIR DIKE	4232.8	7149.7	15FEB80

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	NOTOWN RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	06		FITCHBURG	0	43300

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	(27) IMPOUNDING CAPACITIES NORMAL (ACRE–FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
EROT	1876	S	18	13	3900	2500	NED	N	N	N	N	15FEB80

(28) REMARKS
21=MORTAR STONE CONEWALL 22=APPROX

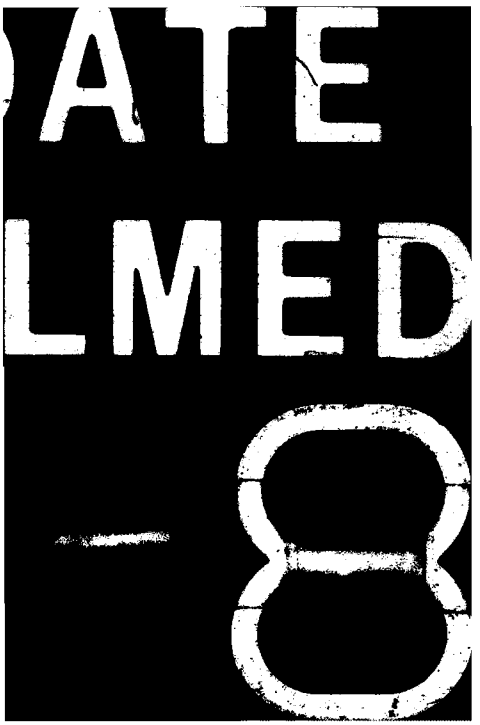
(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) SPILLWAY TYPE	(32) SPILLWAY WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) POWER CAPACITY PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	750	N			17000											100

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
CITY OF LEOMINSTER	GEO RAYMOND	

(49) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(50) INSPECTION BY	(51) INSPECTION DATE DAY | MO | YR	(52) AUTHORITY FOR INSPECTION
HAYDEN, HARDING & BUCHANAN, INC.	05NOV79	PUBLIC LAW 92-367

(53) REMARKS
33=SPILLWAY AT DAM MA 870


ATE
LMED
8